# ROADS AND STREETS

H. P. Gillette Editor

Vol. LXX AUGUST, 1930 No. 8

## TABLE OF CONTENTS


Low Cost Road Future ..... 271

Bituminous Emulsions and Cold Asphalt Road Emulsions ..... 274

Drinking Fountains Along Highways ..... 277

Safety Precautions at Railway Grade Crossings ..... 279

Design of Sheet Asphalt Paving Mixtures ..... 280

Uniform Street Sanitation Records ..... 283

Causes of Traffic Injuries and Fatalities ..... 284

The Largest Highway Bridge in New England ..... 285

New Tax Formulas for Adjusting Motor Vehicle Rates ..... 286

What an English Highway Engineer Must Know ..... 287

Improving Conditions in Highway Construction ..... 289

Concrete Pavement Maintenance ..... 292

Gas Fired Boiler for Asphalt Plant ..... 294

Selecting the Site for an Airport ..... 296

Frost Action in Shoulders and Subgrades ..... 298

State Highway Department Car Operation ..... 300

Editorials:

- Hoover Construction Program Lives Up to Expectations ..... 301
- Man's Most Important Invention ..... 301
- A New Profession, Research Engineering ..... 302

New Equipment and Materials in the Road and Street Field ..... 303

Distributor News ..... 74


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A

*Adams Co., J. D.....Center Insert
*Aeroil Burner Co..... 98
*Alan Wood Steel Co..... 86
American Bitumuls Co..... 77
*American Hoist & Derrick Co..... 89
*American Pressed Steel Co..... 93
*American Steel & Wire Co..... 28
*American Tar Products Co...Center Insert
Anthony Co., Inc..... 93
Athey Truss Wheel Co..... 22
Atlas Imperial Diesel Eng. Co..... 29

B

*Baker Mfg. Co..... 97
*Barrett Co., The..... 73
Barnes Mfg. Co., The..... 25
*Bates Mfg. Co..... 38
*Bay City Shovels, Inc..... 35
*Blaw-Knox Co. ..... 75
Bosch Magneto Co., Inc., Robert..... 7
*Bucyrus-Erie Co. .....Front Cover
Budd Wheel Co. ..... 15
*Buffalo Springfield Roller Co., The..... 96
*Burch Corp., The..... 94
*Butler Bin Co..... 17

C

*Calcium Chloride Publicity Committee 50
Caterpillar Tractor Co..... 34
Chicago Pneumatic Tool Co..... 16
Cleveland Trac. Co., The..... 36
Concrete Surfacing Machy. Co..... 99
*Connery & Co..... 94
*Continental Motors Corp.....Center Insert
Cyclone Fence Co..... 88

D

Dietz Co., R. E.....Center Insert
*Domestic Eng. & Pump Co..... 86
*Dow Chemical Co..... 50

E

Edelblute Co., T. H..... 96
*Electric Wheel Co..... 97
*Erie Steel Constr. Co..... 19
*Etnyre & Co., Inc., E. D..... 97
Everhot Mfg. Co..... 98

F

*Flintkote Roads, Inc..... 52
*Foote Bros. Gear & Machine Co..... 38
*Four Wheel Drive Auto Co., The.....Center Insert
*French & Hecht..... 40

G

*Galion Iron Works & Mfg. Co..... 5
Gardner-Denver Co. ..... 18
*Garst Mfg. Co..... 98
Gillette Publishing Co.....51-Center Insert-82-92
*Gohi Culvert Manufacturers, The..... 33
*Good Roads Machy. Co., The..... 90
*Grasselli Chemical Co., The..... 13

H

Haiss, Geo., Mfg. Co., Inc.....Center Insert
Havana Metal Wheel Co..... 96
Hayward Co. ..... 88
Hazard Wire Rope Co..... 30
*Heltzel Steel Form & Iron Co..... 21
*Hercules Motors Corp..... 31
Highland Body Mfg. Co., The..... 99
*Honhorst, Jos., Co..... 98
*Huber Mfg. Co., The..... 98
Hug Co., The..... 99
Hughes-Keenan Co. ..... 99
*Hyatt Roller Bearing Co.....Second Cover

I

*Independent Pneumatic Tool Co.....Center Insert
Iowa Mfg. Co..... 10

J

*Jaeger Machine Co., The.....93-95
Johns-Manville Corp. ..... 49
Johnson Co., C. S..... 23

K

Kasper Wire Wks..... 98
*Keystone Driller Co..... 37

L

*Littleford Bros. ..... 87

M

Marion Steam Shovel Co..... 39
*Mohawk Asphalt Co..... 90
Mueller Mosaic Co..... 94

N

Natl. Equipment Corp..... 8-9
Natl. Paving Brick Mfrs.' Assn..... 83
Nelson Iron Wks., Inc., The N. P..... 41
Novo Engine Co..... 27

O

*Ohio Power Shovel Co.....Center Insert
*O. K. Clutch & Machy. Co..... 95
Olsen Testing Machine Co., Tinius..... 4
Osgood Mfg. Co.....Center Insert

P

*Page Steel & Wire Co..... 48
Pioneer Gravel Equip. Mfg. Co..... 12
*Pittsburgh Plate Glass Co..... 50
Portland Cement Assn..... 81

R

Ransome Conc. Machy. Co..... 6
*Rawls Machy. Co..... 46
*Riddell Co., W. A..... 94
Robertson Steel & Iron Co., W. F..... 95
*Rogers Bros. Corp..... 97
*Root Spring Scraper Co..... 84

S

*Sauerman Bros. ..... 99
*Schramm, Inc. ..... 87
Shaw Excavator & Tools Co..... 91
*Smith Engr. Works..... 14
*Solvay Sales Corp..... 50
Speeder Machy. Co..... 43
St. Paul Hydraulic Hoist Co., The.....Third Cover
*Standard Oil Co. (Ind.)..... 85
*Standard Oil Co., (N. Y.)....Center Insert
Sterling Motor Truck Co..... 24
*Stockland Rd. Machy. Co..... 38
Stolle Road Equipment Co..... 96
*Sullivan Machy. Co..... 20
*Sweets Steel Co..... 98

T

Thew Shovel Co..... 45
Timken Roller Bearing Co..... 26
*Toledo Pressed Steel Co..... 95
Traction Co. ..... 42
Twin Disc Clutch Co..... 32

U

United States Pipe & Fdry. Co..... 11
Universal Crane Co..... 47
Universal Road Machy. Co..... 93

W

*Wallace & Tiernan Co., Inc.....Back Cover
*Warren Bros. Co..... 79
Warren-Knight Co. ..... 98
Western Crucible Steel Cast. Co..... 94
*Western-Wheeled Scraper Co..... 44
*Wheeling Mold & Fdry. Co..... 84
Williamsport Wire Rope Co.....100
Wood Hydraulic Hoist & Body Co..... 99

Y

Young Radiator Co..... 91


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# ROADS AND STREETS

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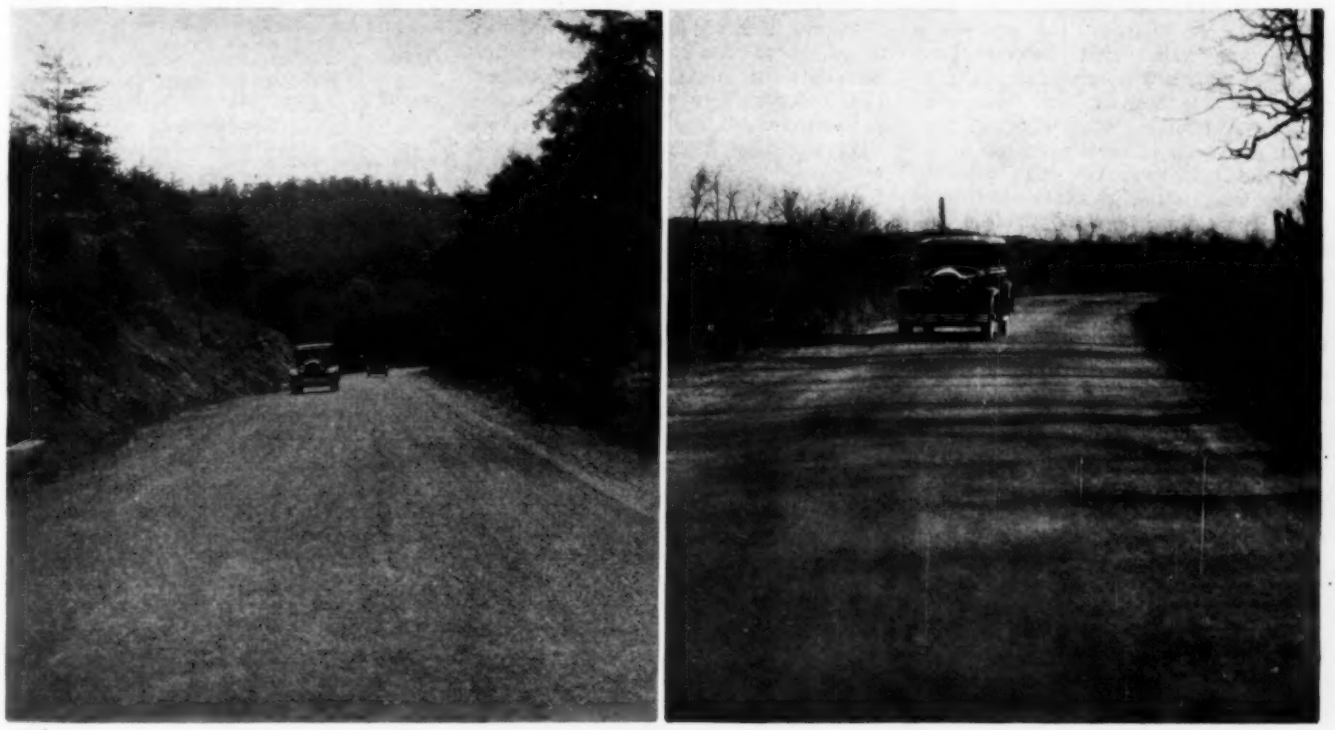


*Left—A 4-Year-Old Bituminous Treated Shale Road in West Virginia. Right—A Thin-Top Macadam Laid by Retread Method Mixed in Place; 3 Years Old; 2 In. Thick on Gravel Base*

# Low Cost Road Future

## In Order that Greater Economic Benefits be Derived by American Communities Low Cost Road Surfaces Should Have Definite Place in the Well Balanced Highway Plan

By B. E. GRAY

Highway Engineer, The Asphalt Institute; Former State Maintenance Engineer of West Virginia

DURING the past two years much has been written concerning low cost roads, some of it a distinct contribution to our knowledge of highway construction while the remainder is a recapitulation of results obtained. In a few instances, emphasis has been given to the stage development phase, whereby annual additions are made to the surface and so designed as to keep ahead of traffic needs, but the great majority of articles have concluded with the statement that these types were largely temporary and to be used merely until they could be replaced with some so-called higher and more expensive ones.

This attitude is believed to be entirely wrong, and that it so largely prevails is because the same research and open-mindedness evident in the structural design of bridges, buildings, subways, dams and similar work has not extended itself as yet in the same degree to the design of road surfaces. To be sure, there has been a tremendous advance made during the past five years, especially through the splendid cooperative efforts made by the Highway Research Board, the American Road Builders' Association and the U. S. Bureau of Public Roads, yet many highway engineers remain wedded to the old orthodox types and use them regardless of conditions of traffic subsoil conditions or future expansion needs.

It is contended that the ultimate development of the so-called low cost road surfaces will find them just as firmly established in their particular place in the entire highway plan as the most expensive type now happens to be, and in many instances will have permanently displaced the latter with equally satisfactory service to traffic, as well as marked reduction in cost.

**Characteristics of a Satisfactory Highway.**—The question may be asked, what constitutes a satisfactory highway, and what are the minimum particular characteristics: These may be listed as follows:

1, Mudless; 2, Dustless; 3, Smooth; 4, Of sufficient width; 5, Cost within ability to pay.

Furthermore, surfaces with these characteristics must be found on all parts of the system, and not simply on a few miles of roads selected either arbitrarily or for political reasons.

There are two ways in which the whole highway problem is being attacked, given a certain sum of money. This amount of money is pretty definitely known, together with limits of

possible taxation for the future. Whether roads are constructed from bond issue funds or from current revenues, makes but little difference, as in the former case it is simply a matter of capitalizing current revenues and providing highways enough earlier with consequent acceleration of traffic volume increase as will not only take care of fixed charges, but provide a balance as well. The probable limit of taxation is a 5 ct. gasoline tax, plus motor vehicle registration fees, plus Federal Aid for the state highway systems, and a 25 ct. levy per $100 or its equivalent for county and township roads, with some possible additional help from diversion of gasoline tax money. From the experience already gained over a number of years, this total can be readily estimated.

**Two Ways of Attacking Highway Problems.**—The first way is to select a certain type of improvement, divide total revenues by the cost per mile, and the answer is the mileage of the system which can be improved. This method has been followed in a surprising number of states, and to the question of those residents on roads not on the selected system, as to what about them, the answer was and still is, "Sorry, but the funds are not available"—with the result that a large number of people have failed to obtain the full measure of benefit from the highway expenditures. They have been silenced, but not convinced, even though without technical knowledge of the situation so as to present logical arguments against the method. However the feeling of dissatisfaction has steadily grown, and has made itself felt to the extent that the second method is being considered more and more. This second way is to survey the highways as a whole and then determine how best to improve and maintain all of it, using lower cost types, local materials and local labor wherever possible, and all the while carrying on experiments and research to still further reduce cost. The county or township road having 200 vehicles per day is just as much entitled to consideration and inclusion within a well balanced system, as the boulevard which carries 10,000 vehicles, the difference being merely one of design. It is obvious that the former road cannot have a pavement costing $30,000 per mile, but it can have and afford to pay for, through reduction of traffic costs, a surface that is mudless, dustless, smooth and wide enough. Moreover, these roads are going to receive adequate surfaces because the public temper will demand it, and it is simply up to the highway engineer to perfect the methods to achieve such a result.

This statement is not to be taken as a criticism of the construction of high cost roads where traffic conditions require such expenditures, and trunk line or primary roads will always require surface designed for heavy traffic needs. But, on the other hand, these same expensive roads are not the answer for the medium and light traffic highways, so that failing to have sufficient funds wherewith to build that type or none at all, or at best to build inch by inch with such short sections each year as will require a long time for completion with no commensurate benefits until the whole route is finished, is, to say the least, a very uneconomical and most unsatisfactory procedure. Low cost surfaces are by no means a panacea for all highway ills, no more than a single track into Philadelphia with 30-lb rail would be the solution for the traffic on the Pennsylvania Railroad. But there is proportion in all things, and just as over a large part of the country's railroad mileage a single track serves the needs, so can low cost surfaces adequately serve the highway needs of the nation over by far the greater percentage of the total mileage.

**Traffic Density.**—Density of traffic on the roads of the United States is not anywhere near as heavy as commonly supposed; the figures obtained in the Cleveland survey clearly demonstrate that even adjacent to a metropolis of that size, traffic diminishes to a relatively small amount, beyond a radius of 15 to 20 miles. Traffic counts on the Federal system, even on such roads as U. S. 30, 40, 50 and 60, located in the most thickly populated part of the country, show less than 1,000 vehicles per day on long sections, and except adjacent to cities rarely over 2,000. On the secondary system, these figures are seldom exceeded, and it is felt certain that it can be conservatively stated that over 80 per cent of the total highway mileage of the United States carries less than 500 to 800 vehicles per day. This being the case, why not design the surfaces accordingly, rather than arbitrarily selecting a single expensive type all the way through purely for reason of sentiment or because of a mistaken public clamor? Savings of such magnitude will be effected by following this procedure, as will provide for many miles of additional road, and they in turn will produce earnings from savings in operating costs as to make possible a still further increased highway development.

**Some Statistics.**—Statistics are tedious and they have been thrown about so promiscuously that the result is often confusing, but a few of them are given herewith, which are illuminating, to say the least. They are taken from the 1929 edition of "Highways Handbook," put out by the Highway Education Board, Washington, D. C.

This makes a grand total of over $12,000,000,000 spent during the past seventeen years. Of this amount, approximately 25 per cent was used for maintenance, leaving a balance of around $9,000,000 which has been expended for new construction and reconstruction.

**Table I—Rural Mileage of Surfaced Highways, Including All State, County and Township Roads, Outside of the Cities of 2,500 Population or More, 1929**

| Type | Miles | Percentage of Total |
|---|---|---|
| Sand-clay | 88,061 | 14.0 |
| Gravel | 370,921 | 59.3 |
| Waterbound macadam | 64,596 | 10.3 |
| Bituminous macadam | 30,153 | 4.8 |
| Sheet asphalt | 2,920 | 0.5 |
| Bituminous concrete | 9,155 | 1.5 |
| Cement concrete | 55,264 | 8.8 |
| Brick, 4,600 estimated, return not available | ..... | ..... |
| Other types | 4,987 | 0.8 |
| Total | 626,057 | 100.0 |
| **Unsurfaced** | | |
| Earth roads, graded and drained | 600,000* | |
| Earth roads, unimproved | 1,790,144* | |
| | 2,390,144 | |
| Grand Total | 3,016,201 | |

*Estimated—report not complete.

These figures may be recombined as follows:

**Table II**

| Type | Miles | Percentage of Total |
|---|---|---|
| Surfaced | 626,057 | 21.00 |
| Graded and drained | 600,000 | 20.00 |
| Unimproved | 1,790,144 | 59.00 |
| Total | 3,016,201 | 100.00 |

Not taking any account of expenditures for highways prior to 1913 there have been spent the following sums:

**Table III**

| Year | State Highway Departments | County and Local Highway Departments |
|---|---|---|
| 1913 | $ 37,438,172 | $ 150,086,021 |
| 1914 | 24,220,850 | 216,042,934 |
| 1915 | 53,491,651 | 213,484,748 |
| 1917 | 47,290,797 | 232,624,535 |
| 1918 | 66,351,477 | 219,749,721 |
| 1919 | 106,861,053 | 282,594,879 |
| 1921 | 384,381,362 | 609,722,205 |
| 1922 | 429,896,572 | 468,455,735 |
| 1923 | 414,807,424 | 523,497,875 |
| 1924 | 559,601,149 | 515,992,540 |
| 1925 | 600,948,372 | 543,467,141 |
| 1926 | 576,016,847 | 587,731,124 |
| 1927 | 639,661,164 | 643,449,467 |
| 1928 | 764,648,134 | 659,222,144 |
| 1929* | 800,000,000 | 700,000,000 |
| | $5,500,000,000† | $6,566,000,000† |

*Estimated.
†Approximate.

**Types of Surfacing.**—Now, referring back to Table II, wherein it is shown that about 20 per cent of roads have surfacing of some kind, and with a conservative estimate that grading and draining is as much as one-quarter the total cost of an expensive type surface, reducing this second item to a percentage proposition, the situation appears as follows: 20 per cent surfaced; 20 per cent graded, or a combined average giving 25 per cent of the total highway need provided for in some form or other. There remains 75 per cent yet to be done, which, based on the most conservative figures in Table III with no account of road building prior to 1913, will require at least $27,000,000,000 even with the same character of construction. Taking as an estimate $30,000 per mile for expensive type paving, to simply place the surface on roads already graded would cost $18,000,000,000. If one still has in mind the complete grading and paving of the yet unimproved 1,790,144 miles and re-

ducing the pavement width to 9 ft., and everything else in proportion, the total cost, plus the years required, would run into figures both astronomical and absurd. And yet, seriously, hasn't the matter been approached something along these lines without really thinking of the ultimate cost or when results shall be achieved adequate for the right-now-traffic needs?

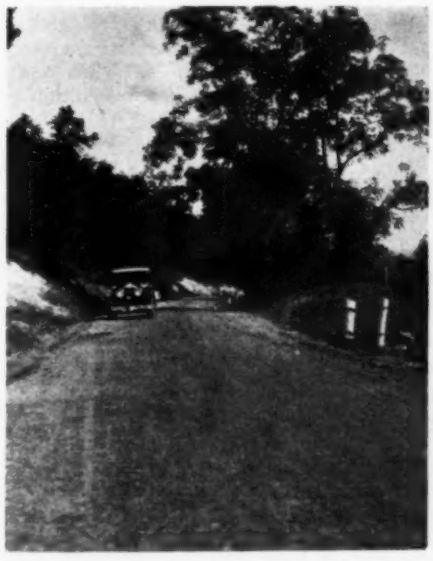
**What Is a Low Cost Surface?**—Having presented these figures, the layman naturally asks, "Well, what are you going to do about it? We know all about the miles of mud roads, and dust roads, and taxes are high enough, so what can you offer as a solution with the money that you have in sight?" The highway engineer will be obliged to answer this question and whatever his desires or prejudices may be, he has no alternative but to give this one, "more miles of lower cost surfaces." Now, what is a low cost surface? Is it a 9-ft. section of concrete or brick placed upon a narrow graded road, and called by such a name simply because the total cost has been cut in half? Not by any means can such a road be called low cost surface. On the contrary, it will in the end prove to be a most costly one, because eventually the roadway will have to be widened, structures lengthened, and alignment revised, so that these expensive roads which should have a long useful life to justify their use will have to be largely discarded in making a revised surface.

A true low cost surface is one which is placed upon a graded roadway of such width as will take care of the traffic for years to come, with but little additional expenditure of funds other than for increasing the carrying capacity of the surface itself. This point should be emphasized not only with state commissions carrying on a large program, but also for all county work. It is far better to grade the road properly to adequate width, install long culverts, and proper drainage, omitting the surface entirely for the time being rather than to attempt to make a one-half way piece of work by combining both inadequate width and improper surfacing. Such a policy allows for settlement of fills and stabilization of weak places, so that when the pavement is laid its useful life will be much longer.

The question might be asked again, is a low cost surface one that can be placed in a "hit or miss" fashion and without any regard for engineering principles, and again the answer is decidedly no. Low cost surfaces that are producing satisfactory results throughout the United States are those which have been developed as the result of intensive and careful research, and their construction requires expert knowledge of the physical, chemical and mechanical characteristics of the material employed and at attitude of mind which is receptive to new methods and yet keenly discriminating.

Mr. Frank Sheets, Chief Engineer of Illinois Highway Department, has recently set forth these principles most admirably in his statement to county authorities relative to the development of the secondary system in that state, and the new 1930 specifications describe a number of types to be used on the different parts of the road system.

Mr. E. W. James, Chief, Division of Design, U. S. Bureau of Public Roads,



**A Bituminous Treated Gravel Road in West Virginia**

in a paper presented before the 7th annual Asphalt Paving Conference in New Orleans, 1928, sets forth the situation as follows:

. . . "Note first that there are 1,822,867 miles of roads still unimproved. Of the improved roads, over 600,000 miles are graded and drained only and have no surfacing of any kind. Over 300,000 miles are of gravel, very little of which has been surface-treated. The total mileage of types below waterbound macadam represent over 1,000,000 miles, or approximately 88 per cent of all improved roads. Waterbound macadam, most of which has undoubtedly been surface-treated, the bituminous macadam represent another 85,000 miles, or approximately 7 per cent of the entire improved mileage.

"It is the group of low-type improved roads represented by gravel, sand-clay and graded and drained earth, that furnishes one of the most serious problems facing the highway engineer and the several states at the present moment. These roads have been improved under a variety of conditions and, apparently at the time the work was done, the improvement was adequate for the existing traffic. There is a powerful and effective force of public opinion directed toward the improvement of a large mileage and this unquestionably is going to be effective for many years longer. This will encourage the continued construction of low-type roads." . . .

Returning to Table III, we find total expenditures for 1928 of $1,423,870,278, of which over $1,000,000,000 was for new construction or reconstruction. This money was spent for the following types:

**Table IV**

| Type— | Miles |
|---|---|
| Sand-clay | 4,718 |
| Gravel | 29,844 |
| Waterbound macadam | 4,007 |
| Bituminous macadam | 3,610 |
| Sheet asphalt | 308 |
| Bituminous concrete | 640 |
| Cement concrete | 7,200 |
| Brick | 134 |
| Miscellaneous | 4 |
| Total surfaced | 50,465 |
| Graded and drained earth | 24,318 |
| Total improved | 74,783 |

Assuming an average cost of $30,000 per mile for expensive types, this kind of construction took care of $260,000,000, or 25 per cent of the total amount available to build only 11 per cent of the total mileage. This leaves an average cost for the remaining 89 per cent of $11,000 per mile. Considering the gradations of the several types of surfacing included in this category, many, many miles received less than $5,000 per mile.

Thus it can be seen that already low cost surfaces are being used to a large extent, being 84 per cent of the total mileage placed. So far so good. But now, instead of planning to replace this low cost mileage with an expensive type later, and in the meantime employing expensive methods of maintenance, such as replacements of material blown away from the surface, of sand-clay, gravel and crushed stone surfaces, why not accept such types as the logical construction in their particular locations, protect the surfaces with the proper bituminous wearing cover, and year by year thereafter employ maintenance funds in building up such a durable wearing coat as to provide large cumulative benefits, and by such methods have additional money available for new roads with brand new construction. Taking this attitude will result in large benefits, not only to the public, but will solve many a difficult situation for the authorities laying out a system.

Any road commissions, vested with the mandate of the legislature to set up a highway system, will testify to the difficulties encountered in making a choice between the many routes advocated for inclusion therein. If low cost surfaces were employed to a greater extent, two routes could be established, the traffic volume would be cut in two, greater areas would be served, business stimulated, farms made more productive, greater harmony and contentment obtained, all at no greater cost, but even with the further certainty that revenues from the two routes (available for further construction) would be much in excess of those received from but one.

# Bituminous Emulsions and Cold Asphalt Road Emulsions

## A Simple Exposition of the Constitution, Properties and Uses of Asphalt Emulsions in the Highway Field

By COL. H. L. BOWLBY

General Manager, Flintkote Roads, Inc., New York, N. Y.

AS the sale of road emulsions progresses, greater interest is taken in their composition, and many people connected with road construction have written articles on the preparation and properties of these products. Some of these are accurate and some are not, but generally speaking they are not clear as to the essential facts which distinguish emulsions from other liquids.

The use of water instead of heat as a vehicle for forcing asphalt into the body of the wearing surface of a broken-stone or gravel road is quite revolutionary in American road building practice.

**Emulsion Defined.** — The question which first comes to mind is: How can water help or aid in saturating a mass of broken stone or gravel with asphalt? This brings up at once another question, viz.: What is an emulsion? When asphalt in a very finely divided state is held in suspension in water the resulting fluid is called an emulsion of asphalt in water. The asphalt is broken up into microscopically fine particles which are surrounded by or floating in the water.

An emulsion is nothing more nor less than one liquid very finely subdivided and suspended in another liquid, with which it is not miscible. We must use the words, "miscible" and "immiscible" when discussing emulsions.

A more technical definition is as follows: "An emulsion is a heterogeneous system containing two normally immiscible liquid phases, one of which is dispersed as fine droplets or globules in the other. The inner phase or the liquid which is broken up into the fine droplets is known as the dispersed phase, and the other liquid throughout which the droplets are distributed is known as the continuous phase."

In an emulsion having a useful concentration, the globules of the dispersed or suspended liquid would run together and separate out from the bulk, if not prevented from doing so. Therefore, for practical purposes it is essential that emulsions should be stabilized, i.e., the globules should be made to remain in suspension.

The globules of bitumen are surrounded by a film of some substance which renders it more difficult for any two globules to run together or "coalesce."

**Property of Colloids.**—As the globules are exceedingly fine it would obviously be impossible to coat each one separately so that a "mass production" process has to be resorted to. This process consists in the employment of a "colloid." "Colloid" is a technical word synonymous with "emulsifier." What is a colloid? Essentially a colloid is a substance which when suspended in water or other medium breaks down into particles, which though larger than molecules (the smallest particles of matter capable of separate existence) are so small as to be visible only under the ultramicroscope. The ordinary microscope is of no avail for this purpose. Another characteristic property of colloids, which is often used to define them, is that when suspended in water inside a membrane such as parchment, they do not diffuse through the membrane into the outer water. Substance like salt, which are crystalloids, pass easily through the membrane.

Colloids possess the peculiar property, when suspended in water in which bituminous globules are floating, of concentrating at the surface of the globules and, as it were, surrounding the minute spheres with a film which prevents any two such particles from running together, merging or coalescing.

The use of a colloid, therefore, in the water of an emulsion serves to prevent the asphalt globules from running together and separating out. The colloid is usually termed the "emulsifier."

What colloids may be used? Undoubtedly the most effective type of colloid to use for asphalt emulsions is some form of soap. A soap is a very sensitive material and alters its characteristics very readily with slight changes in the method of preparation. It is necessary to adopt very strict standards if soap is to be successfully employed in emulsion manufacture. Other colloids which are used by some manufacturers are starch, glue, gum, Irish Moss extract, resinates, chinawood oil and many others.

All these will render emulsions stable. Colloids possess the property of concentrating at the surface or interfaces of their solutions. This is the reason why they stabilize emulsions. They concentrate at the interface of the oil globules and the aqueous continuous phase, and form a protective film round the globules which prevents them from coalescing. This film is spoken of as the "adsorbed film" or "adsorbed layer." In simple, non-technical English this film may be called a soap bubble.

The surface of a liquid behaves like a taut membrane. There is what is known as "surface tension." This is due to the unbalanced attraction of the molecules in the bulk of the liquid for those at the surface. Colloids greatly reduce the surface tension of the liquid in which they are dissolved. This reduction in surface tension results in the formation of the adsorbed film above mentioned, and is the first criterion for efficient emulsification.

**Straight and Reversed Emulsions.**—Some emulsifiers favor the formation of water-in-oil emulsions. Such emulsions, in which water globules are floating in a continuous phase of oil, are called reversed emulsions. The more usual type of emulsion is where the oil globules are floating in water. These are known as straight emulsions. This is the only type which is useful in road construction. Think of a mass of very fine soap bubbles, microscopical in size, and each bubble containing a speck of asphalt.

Usually the two phases of an emulsion have different densities. Thus there is always a tendency for the lighter phase to rise and the heavier phase to sink. This produces a gravitational separation of the phases as time goes on. This phenomenon is called sedimentation. The amount to which an emulsion will sediment depends on the difference in density between the two phases, the viscosity or thickness of the emulsion, the size of the particles, and on the time for which the emulsion has stood undisturbed.

**Quick-Setting and Slow-Setting Emulsions.**—Limiting our discussion for the moment to only asphalt-in-water types of emulsion, it may be observed that, from the emulsifying agents classified above, there result emulsions of two general types:

1. Emulsions which coalesce prior to dehydration.

2. Emulsions which must dehydrate prior to coalescence.

The first type of emulsion generally "sets" or breaks more rapidly than the second. It is very sensitive to the introduction of foreign substances, par-

ticularly to electrolytes which precipitate the emulsifying agent, and to admixtures with mineral powders, or to any change brought about in the nature of the electric charge upon the particles.

The second type of emulsion generally "sets" more slowly than the first. It is more stable than the first and will permit incorporation of a greater or less variety of electrolytes and of substances of other types, depending upon the specific agent used.

The great variation in properties of the above two types of asphalt-in-water emulsions lends itself to widely different fields of industrial uses.

**Limiting Ratio of Equal-Sized Particles.**—All these factors are summed up in Stokes' Law. According to Stokes' Law the particles in any emulsion will rise or fall to an extent dependent on their size. This would imply that the biggest particles settle out first, followed by successively finer fractions. This is what happens provided the concentration of disperse phase is not too high. Above a certain limit of concentration, the particles are so tightly packed that the big ones drag down the small ones with them and the emulsion sediments as a whole.

There is a limit to which equal sized particles assumed to be spheres can be packed. This occurs when the ratio of disperse phase to continuous phase is 74:26. With particles of graded sizes such as are met with in almost all emulsions, packing may proceed to very nearly 100 per cent disperse phase. Thus emulsions can be prepared in which 99 per cent of benzene is dispersed in 1 per cent of soap solution.

Asphalt is a compound substance and can be emulsified under circumstances where pure bodies, such as benzene or toluene, will not emulsify. This is due to the fact that asphalt contains acid substances which combine with alkalis to form colloids or emulsifiers. Thus an asphalt may be stirred into a warm alkali solution and will emulsify.

Ahe average size of the asphalt particles in some emulsions is one ten-thousandth of an inch diameter or $2\mu$. ($\mu$ is one thousandth of a millimeter).

Under present conditions of manufacture experience shows that a good emulsion contains between 55 and 60 per cent of asphalt.

The tests defining the asphalt which should be used in an emulsion for spraying or grouting are—

(a) Penetration of 180-200 at 77°F.

(b) Ductility of over 100 cms. at 77°F.

(c) Bitumen should be almost completely soluble in carbon bisulphide.

**Methods of Preparing Emulsions.**—The essential factor in preparing an emulsion is to agitate the two liquids together in the presence of the emulsifier. The following methods of agitation may be employed:

(1) Shaking—Intermittent shaking is more effective than continuous.

(2) Slow stirring—In the older processes a slow stirring mixer was employed, and advantage was taken of the chemical action between the two constituent parts of the emulsifier to supplement this.

(3) Trituration.

(4) High speed agitation. An interesting form of high speed agitator is the colloid mill in its various forms. The feature of the colloid mill is that the two liquids, disperse phase and emulsifier solution, are brought into contact under conditions of tremendous mechanical disintegration, usually in a narrow zone between a stationary member and a rotor revolving at some thousands of revolutions per minute.

**The Use of Emulsions in Road Building.**—The use of emulsions in road construction is a consequence of the demand for a material not so subject to weather conditions as hot asphalt or tar. In this connection it is necessary to bear in mind one physical fact: asphalt will not stick to stone in the presence of free water. Thus, although emulsions may be satisfactorily applied in nearly all weathers, the great problems in the use of emulsions is: How long will the water take to disappear?

Water may be lost from an emulsion after application to the road in three ways:

(1) Evaporation.

(2) Capillary Action.

(3) Mechanical Disturbance.

As between one emulsion and another there is little difference to be observed in the rate at which water evaporates. The water behaves almost as if it were pure water, and the rate of evaporation is controlled by the temperature, humidity and wind velocity. The last named factor is particularly important; a breeze of 12-15 m.p.h. will increase the rate of evaporation 10-15 times over that in still air.

**Capillary Action.**—Capillary action on an emulsion is illustrated in the rate of break test. The surface tension forces brought into play by the absorbent paper, used in this test, cause the water to leave the emulsion and saturate the paper. Certain types of road are porous and exert a similar action. While on every dry road, however well swept, there is always a considerable amount of dust which acts as an absorbent. The loss of water in this way depends much more on the emulsion than is the case with evaporation. Generally the viscosity of the emulsion affects its rate of break under capillary forces. The thicker the emulsion the more slowly it loses water on porous materials.

Mechanical disturbance as a cause of loss of water in the setting of an emulsion does not enter the picture until a considerable proportion of the original water has been lost by evaporation and capillary agencies. When a certain water content is reached the mere exertion of mechanical pressure on the emulsion film will cause the complete coagulation of the bitumen. Again, this is not true of all emulsions, but is an important property for a road emulsion to possess. In the final stages of the setting of the emulsion the mechanical disturbance caused by rolling and passing traffic may be very important.

**What Happens to an Emulsion on the Road?**—A great deal could be said on this subject but for the moment suffice it to say that some of the water runs away taking the dissolved emulsifying agent with it. Some evaporates. A film of asphalt is left all around each piece of stone in the road securely binding it to its neighbor. The thickness of this asphalt film may be controlled in an emulsion by concentration of emulsion and a number of applications. In this method of application there is sufficient asphalt to give a good bond, but no excess with its many attendant troubles including "bleeding" and pushing out of shape.

**What Does the Water Do?**—It enables the asphalt to be applied directly to the road without heating.

The asphalt required for a given job is reduced to a minimum.

It makes penetration possible.

The watery envelope (soap bubble) surrounding the asphalt particles will spread upon a damp surface to which hot asphalt would not normally adhere.

**What Becomes of the Water?**—When applied to the road surface, the emulsion separates:

(a) The asphalt particles running together or coalescing. (Below 40°F. the small asphalt particles do not coalesce but resemble in a minute form a mass of "caviar".)

(b) The water and emulsifier evaporate, are absorbed or run off the road.

Water in an emulsion enables:

(a) The asphalt to be applied cold.

(b) A minimum of asphalt to be used.

(c) The greater penetration to be achieved.

(d) Permits work being done in wet weather.

Wherever water penetrates, such an emulsion properly made will follow leaving a film of asphalt throughout the mass of the road metal and coating each piece of broken-stone or gravel with which it comes in contact with a thin covering of asphalt.

Asphalt emulsions have been manufactured in America for many years but their use in road construction has been limited principally to cold-patching, railroad grade-crossings and station platforms. These early emulsions were very stable, that is, the exceedingly fine particles of asphalt were in such stable suspension in the water that a long period of time was required for the water content to evaporate and for the asphalt to be deposited when the

emulsion was used in road construction. Great improvements have been made in the art of manufacturing cold asphalt emulsions so that now we can accurately control the time that is required for the water content to disappear after the emulsion has been applied to the road. That is, the "rate of break" of the emulsion can be varied at will during its manufacture.

Emulsions have been extensively used for over seven years in nearly all European countries and are proving to be the solution of their most important road problem: How to build durable low-cost roads and utilize the thousands of miles of existing macadam and gravel highways.

Emulsions are used in cold and damp weather as well as in fair. Only severe rains and weather below 40°F. stop the construction and repair of roads. A more ductile and elastic asphalt may be used as the binder by the emulsion method than by the hot process. In the hot penetration process of asphaltic road construction it is customary to use a fairly hard asphalt (low penetration) to lessen the tendency of the wearing surface to soften in summer with the accompanying waves and bulges. If excess asphalt occurs it acts as a lubricant as well as a binder and to overcome this disadvantage the harder grades of asphalt are specified. The surplus bitumen, however, finds its way to the road surface and is the cause of a slippery road in wet weather.

**Method of Constructing a Wearing Surface.**—To construct a wearing surface by the cold asphalt emulsion penetration or grouting method the broken-stone or gravel wearing course is brought up to grade and contour, thoroughly compacted by sprinkling and rolling until inherent stability and a practical minimum of voids are obtained in the mineral aggregate. Standard water-bound macadam practice should be followed except for omitting the extreme fines and the dust. When the surface is firm, and while the stone is still wet if possible, the emulsion is poured or sprayed upon the road and, because it is cold, thin and extremely liquid it penetrates throughout the mass of the crushed stone or gravel. Before the emulsion has had time to "break" or "set" ½-in. stone chips or gravel are spread over the surface and thoroughly rolled. Traffic may be turned on to the road within 20 or 30 minutes. After this road surface has been carrying traffic for some days, a sealing coat of emulsion is applied at the rate of 1 gallon to 4 sq. yd. This is immediately covered with ¾-in. stone chips, pea gravel or clean, coarse sand and rolled. When correctly applied, due to the absence of an excess of asphalt binder, the road will not become soft or wavy in hot weather.

Such a road is skid-proof. No film of asphalt remains on the road surface. A softer, more elastic and ductile asphalt is used. Should any slight damage occur to the road surface the mass seals up again under traffic.

This quick-setting type of asphalt emulsion must not be confused with cut-back asphalts and tars. The latter employ a solvent such as naphtha or gasoline, to facilitate the use of cold bitumens in road construction. The solvent disappears only by evaporation. An emulsion, however, actually "breaks" and in 20 to 30 minutes the water content has evaporated, been absorbed, come to the surface or run off the road. With cut-backs the interior of the wearing surface course remains soft for a comparatively longer period.

Acknowledgment.—The foregoing is an abstract of a paper presented May 28 before the Boston Society of Engineers.

## Thompson is Road Congress Manager

Appointment of J. Trueman Thompson, Professor of Civil Engineering at The Johns Hopkins University, as manager of the 6th International Road Congress, has been announced by Thomas H. MacDonald, Secretary-General. The congress, which will attract leading highway engineers, administrators and economists from virtually every civilized country in the world, will meet in Washington Oct. 6 to 11 at the invitation of the United States government.

Professor Thompson has been a member of the faculty of The Johns Hopkins School of Engineering for the past ten years, while since 1921 he has served as specialist in highway research for the United States Bureau of Public Roads. His studies have included programs dealing with measurement of motor truck impact, determination of stresses in highway pavement slabs and structures, and stress investigations conducted upon model highway bridges.

Under cooperative agreements between the university and the bureau these researches have been conducted at the Experimental Station of the Bureau of Public Roads at Arlington, Va., and in the laboratories of the university where he was teaching. The results of these experiments have been published at various times in the current engineering journals.

Professor Thompson is a member of the American Society of Civil Engineers, and for a number of years he has served on the Highway Research Board of the National Research Council as university contact for Maryland.

As manager of the Road Congress he will have charge of detail arrangements for one of the most representative gatherings that has been held in the United States. He has established an office at the headquarters of the American Organizing Commission, which is in charge of the Congress, at 1723 N St., N. W. Washington.

The meeting in Washington will mark time that the international conference of highway experts has been held in the Western Hemisphere, previous sessions having been at Paris, Brussels, London, Seville and Milan. These congresses are under the general direction of the Permanent International Association of Road Congresses, with headquarters in Paris, of which M. LeGavrian is Secretary-General.

One of Mr. Thompson's duties will be to confer with M. LeGavrian by letter and by cable regarding the many pressing details of transporting delegates from the far corners of the earth to the meeting in Washington, the translation and distribution of reports and addresses, arrangements for the comfort and entertainment of the delegates, and places of meeting. The languages of the congress will be French, Spanish, German and English.

It is expected that the sessions of the congress will be at the building of the Chamber of Commerce of the United States, where ample facilities are afforded for group meetings and for the larger assemblies.

The American Organizing Commission, which has the responsibility for the congress was named by the Secretary of State, with Roy D. Chapin, chairman of the highways committee of the National Automobile Chamber of Commerce, as president, and Thomas H. MacDonald, chief of the United States Bureau of Public Roads, as Secretary-General.

## Distributing Road Contracts Through the Year

The Executive Committee of the American Association of State Highway Officials at its session May 26 at Washington, D. C., passed the following resolution:

"On behalf of the Association it was recorded that the Highway Departments favor using their influence to dissipate peaks of contract lettings so that they may be distributed through the year, not only in the interest of labor but also for the more satisfactory distribution of materials and the purchase of equipment necessary for the work. To this end the Committee on Co-operation with Contractors and Committee on Co-operation with the American Road Builders' Association were requested to lend their assistance to the Manufacturers' Division of the American Road Builders' Association and the Contractors to bring about satisfactory conclusions."

### Blower Cleans Virginia Roads

A blower is used by the Department of Highways of Virginia for cleaning dust from roads preliminary to surface treatment. The blower pipe extends to within about 6 in. of the ground, where it flares into a 20x1½-in. nozzle. The blower is attached to a Fordson tractor. Eighteen of the units were built for the department at one time.

# Drinking Fountains Along Highways

## The Designs of Fountains for Oregon Highways Are Varied According to Available Materials and the Water Supply

IN the days of horse-drawn traffic provision was made along the highways for supplying water for the horses. Spaced every four or five miles apart, depending on the spring or other means of supply were watering troughs. These troughs were a matter of utility rather than beauty, although they were counted of sufficient importance in some states to be included in standards of their state highway department. When the motor vehicle drove the horse off the pavement, these watering troughs fell into disuse and the majority disappeared. The great increase in recent years in automobile traffic has again led to a need for drinking water along the highways. To meet this need many watering places of stage coach days have been revamped and more modern facilities installed or new supplies have been developed. Some states, Oregon in particular, as we learn from an article in "Public Roads" by T. M. Davis, Highway Engineer, U. S. Bureau of Public Roads, have gone so far as to erect artistically designed drinking fountains for the use of motorists. Some illustrations of these fountains reproduced from photographs furnished by the U. S. Bureau of Public Roads are shown herewith.

**The Oregon Fountains.**—For the Oregon fountains no standard plans have been prepared, each fountain being designed by the engineers to harmonize with the surroundings and to make use of the native materials at hand. Though the same general scheme is followed, the designs differ, being influenced by available materials, site, and quantity of water.

At the springs a small reservoir of concrete or cement rubble masonry is constructed, from which a pipe leads to the fountain. Each reservoir has overflow and drain pipes. The fountains are of native rock, some of them built of hand-faced stone, while others are of rubble masonry, using bowlders or large-size gravel.

In most instances the fountains were constructed by the regular maintenance forces of the state highway department, though some were constructed by contractors' forces. In the erection of five fountains in Oregon by the United

States Bureau of Roads, built according to the same general plans as the state fountains, it was found cement rubble masonry fountains cost from $200 to $300 each.

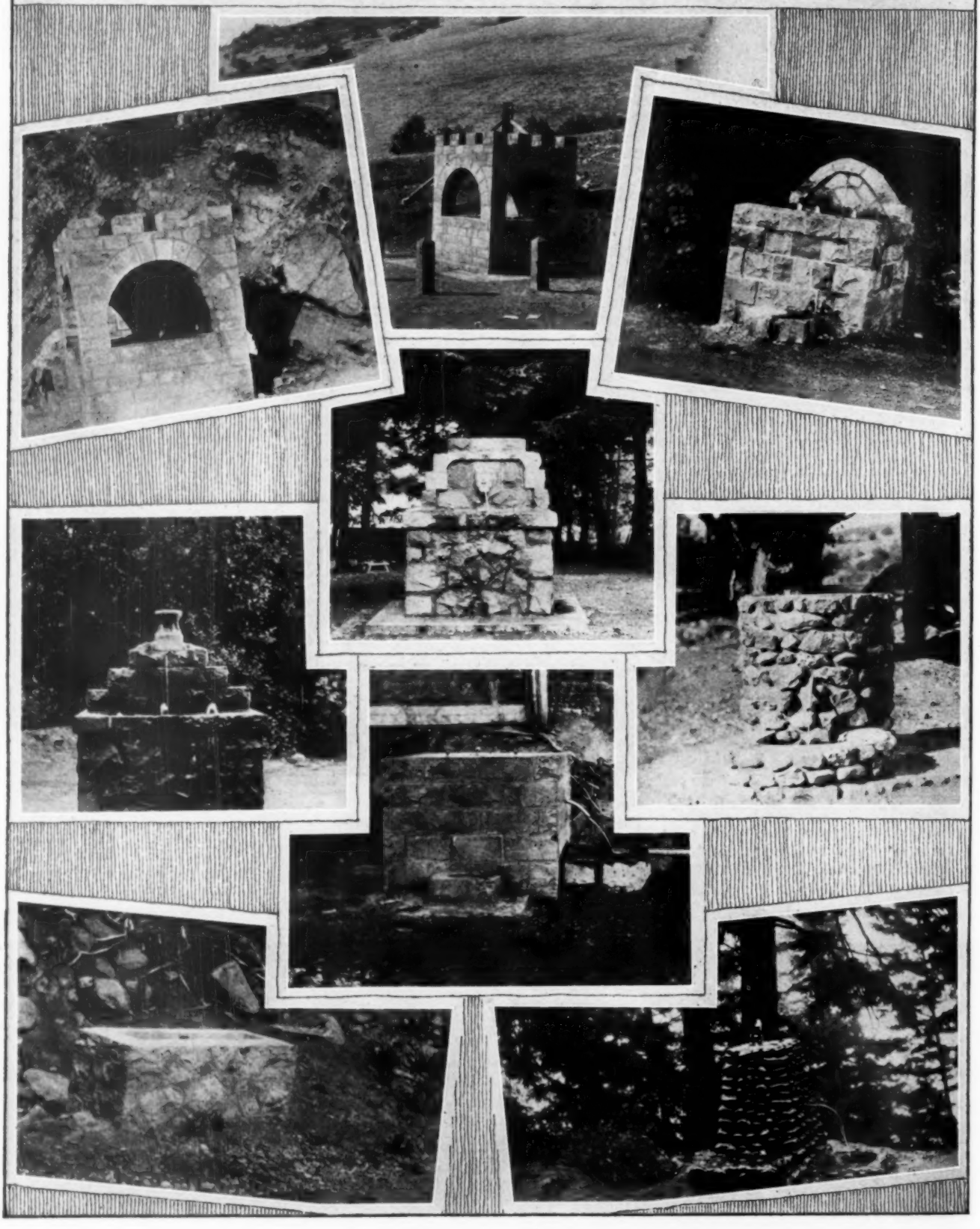
The fountains have bubblers for drinking, and a pool from which water

for filling radiators may be dipped. When there is not a sufficient supply of water for bubblers a small pipe has been used for drinking purposes. Many of these fountains have been built with a step at one of the bubblers, making it more convenient for children. The pools are used mostly for obtaining water for filling radiators, and a few of the fountains have a small pool constructed near the ground for the use of dogs or other small animals. Shut-off and drain valves are used so that proper care of the fountain may be taken during severe freezing weather.

The water used is from live springs and is tested by the state to ascertain its suitability for drinking before the erection of a fountain. Signs are placed about 300 ft. each side of the fountains, calling attention to drinking water ahead, and at the fountains themselves ample parking space is provided so that cars may be parked off the highway.

It is found that these fountains are a great convenience to motorists, and they are used by a great many people during the summer months, particularly on the heavier traveled highways. Many are situated at scenic locations with tall evergreen trees and beautiful shrubbery, ferns, and wild flowers; and motorists find it a joy to tarry for a

# The Site and Available Materials Were Considered in the Design of these Fountains



few minutes' rest. During the summer days there will generally be found one or more cars at each fountain, the travelers resting a minute or two and obtaining a drink of cold spring water, or filling a hot radiator with fresh, cool water.

At present there are some 30 fountains along the Oregon highways, and additional ones are placed wherever suitable conditions are found. The construction of these fountains by the Oregon State Highway Commission is in line with their policy of developing the scenic features of the highways of the state.

# Safety Precautions at Railway Grade Crossings

REDUCTION in the speed of automobiles when approaching railway grade crossings to 15 miles an hour if the view of the tracks is not clear and unobstructed for at least 400 ft. in both directions, is defined by the Third National Conference on Street and Highway Safety as an essential precaution in preventing accidents at these places.

If the obstruction to view is extreme, or there is other unusual danger, the conference favors a complete stop before entering on the tracks.

If the operator of the vehicle can see the tracks for 400 ft. or more in both directions, a speed of 25 miles an hour at the crossing is indicated by the conference. The reckless driving penalty, in the view of the conference, should be enforced against drivers who pass over crossings at speeds in excess of 25 miles an hour.

Crossings should not be entered upon at any time, according to the conference, until the vehicle operator has exercised due precaution, and has definite assurance that a train is not approaching from either direction.

In considering the crossing problem the conference pointed out that notwithstanding the work of eliminating grade crossings, the expenditure for which has averaged $60,000,000 a year for the last three years, the number of new crossings is increasing faster than others are being removed by viaducts or underpasses. In 1928 there were 1,204 crossings eliminated, and 2,068 new crossings were opened to traffic.

While the accidents at crossings have remained at slightly less than 6,000 a year since 1925, and there has not been an appreciable increase in the number of deaths per year at such places, still the number of deaths in 1929 was 2,485, and 6,804 others were injured.

The situation is such that the conference urgently declared that protection of crossings through more adequate signs, signals, and markings, as well as greater safety precautions by vehicle drivers, are essential to reducing this phase of the accident toll.

In considering the elimination of crossings, the conference said:

"Elimination of railway grade crossings, either by relocation of highways or rail lines or by grade separation, which constitutes the only perfect solution of the problem, should be carried on under a proper program. First for elimination should be the most dangerous crossings on thoroughfares carrying heavy traffic.

"The program should have due regard to the relative costs and advantages of grade crossing elimination, and other methods of protection, and should be given the most thorough joint consideration by proper authority. In laying out new highways or railroads, or relocating existing highways or railroads, grade crossings should be avoided or eliminated whenever feasible.

"In eliminating grade crossings, narrow or obstructed underpasses and sharp turns in the approaches, should be avoided. Authority to order grade separations or proper protection at grade crossings should be vested in the commission having jurisdiction over the railways, and this commission should also determine the proper division of costs between the railroads and the public in states where this is not predetermined by state law.

"The state highway department or other highway authorities should plan the improvement and initiate the proceedings for all highways under their jurisdiction. Time is an essential element and a prompt decision should be provided for in the law."

Of the 240,000 grade crossings in the United States, 205,933 are protected by fixed signs; 5,707 have crossing gates; 7,297 are provided with crossing watchmen; 8,004 have visible and audible signals; 3,635 have visible signals only; 4,572 have audible signals only, and 4,941 have no signs or markings at all.

The conference stated that in order to facilitate the prompt arrangement of more adequate protection at crossings there should be a fair division of the costs, including the elimination of obstructions to view and other hazards, between the state or county governments and the railroads. The conference said:

"Protection of railway grade crossings should include reduction of physical hazards and the installation of special protective measures.

"Reducing physical hazards to a minimum requires a practically level and smooth highway surface over the tracks for at least 25 ft. and preferably 50 ft. on each side; approach on grades not exceeding four or five per cent; widening the roadway at crossings; avoidance of sharp turns and junctions within 250 ft.; avoidance of standing railroad cars; parked highway vehicles or other temporary obstacles; and removal of banks, trees, shrubs, standing crops, buildings, billboards or other permanent obstructions to sufficient view; special care where artificial lighting of crossings is practicable to locate the lights so as to illuminate the fixed signs without glare interfering with visibility."

The conference recommended that each crossing should be provided with standard fixed signs, as follows:

1. An advance sign at each highway approach; in addition, on hard surfaced, heavy traveled highways, and where railroad traffic is fast or frequent, the standard form of pavement markings approved by the American Association of State Highway Officials.

2. If the view of the track is not obstructed and no special hazard exists, a 25-mile speed sign; if the view is obstructed a 15-mile speed sign; and if due to extreme limitation of view or other special hazard the proper authority has designated the crossing as one at which all vehicles must stop, a standard stop sign; where the speed or stop sign cannot be seen sufficiently in advance, a standard slow sign in advance of the stop sign.

3. At all crossings a standard railroad cross-buck sign carrying indication of the number of tracks in the case of multiple tracks.

At crossings where the movement of trains is frequent the conference believes that other means should be provided to give warning to the vehicle driver. Such warnings, the conference said, should consist of: Automatic train approach signals of either wig-wag or flashing lights, or manually controlled gates, signals or watchmen where frequent switching movements, or shortness of intervals between trains, require more prompt indications and clearances of the crossing.

## Highway Engineers Publish Regimental Paper

The Twenty-third Engineers, that highway and bridge construction regiment which was recruited by extensive technical journal advertising in 1917, has commenced publication of a newspaper for its members.

As the men came from every state in the union there is slight chance of their being together again, but this periodical will aid in renewing friendships formed during the World War.

The new paper is named "The Highwayman," as was the one published overseas by the regiment.

Subscriptions, at $1 per year, may be sent to Edward T. O'Day, 181 Highland Ave., Lowell, Mass.

# Design of Sheet Asphalt Paving Mixtures

## Primary Requisites of a Satisfactory Mixture and Principles of Design in Light of Most Recent Research and Their Application

By PREVOST HUBBARD
Chemical Engineer, The Asphalt Institute

SPECIFICATIONS for asphalt paving mixtures are usually quite detailed in character, but contain such a wide range of limitations in proportions, as to make the adoption of any specific formula within these limitations, a matter of expert judgment. Specifications for the individual constituent of the paving mixture are also often quite detailed, and tend so to obscure the basic principles of design, that the entire subject is apt to be confusing to the engineer that has not specialized in it.

Factors governing the design of asphalt paving mixtures have been intensively studied by a number of investigators during recent years, and considerable new information has been gotten; which, if intelligently applied, should result in the simplification of existing specifications, and dispel the haze of obscurity that has surrounded the subject, as viewed by most highway engineers. To develop the principles of design at all adequately, in this necessarily brief discussion, it will be advisable to confine attention to a single type of mixture; and sheet asphalt has been selected for this purpose.

**Constituents of Sheet Asphalt.**—Sheet asphalt paving mixture is composed of three constituents: sand, mineral filler and asphalt. While among different mixtures the proportions in which these constituents are combined, may vary to a considerable extent, the following weight proportions represent a fair average: sand, 75 per cent; filler, 15 per cent; and asphalt, 10 per cent. The weight basis of proportioning is the most accurate and satisfactory for use in preparing the mixture, but volume proportions are of far more interest from the standpoint of design. Volume proportions may be readily calculated from known weight proportions, if the specific gravity of each constituent is known. In considering volume proportions, the sand and filler may be taken collectively as total mineral matter. On this basis, if the sand and filler of the usual mixture have a specific gravity of 2.65, and the asphalt one of 1.03, the volume proportions will be approximately 78 per cent total mineral matter and 22 per cent asphalt.

When the paving mixture is compressed on the street, it is seldom completely free from air pockets that must be considered as voids. For reasons to be later developed, voids are an important part of the mixture. If, for the sake of illustration, they are assumed to be 3 per cent, then the volume proportions of the usual compressed mixture would be approximately 76 per cent mineral matter, 21 per cent asphalt, and 3 per cent voids.

The structural strength of the compressed mixture, or its ability to carry loads, is mainly dependent upon the mineral aggregate; which constitutes the entire framework, and three-fourths of the total volume of the structure. The asphalt imparts cohesiveness and tensile strength to the mixture, and at the same time, a certain degree of plasticity. It also fills most of the voids in the mineral aggregate framework, and waterproofs the entire structure. The unfilled voids or air spaces might, at first thought, appear undesirable or at least useless; but actually they are of value in providing a reservoir within the structure, to care for the increase in volume of the asphalt at hot summer temperatures, due to its higher coefficient of expansion than that of the mineral aggregate.

**Two Primary Requisites.**—Resistance to displacement under traffic, and durbility are the two primary requisites of a satisfactory compressed asphalt paving mixture. No matter how carefully and scientifically the mixture is designed, it will be lacking in both of these properties if it is not thoroughly compressed. For any properly designed mixture, resistance to displacement has been found to be almost a direct function of its degree of compression. From the standpoint of design, those factors that control resistance to displacement, as measured by the stability test, which has been fully described elsewhere, are as follows:

1. Inherent stability of the sand when compressed, which characteristics varies greatly among different sands even of the same approximate grading.
2. Physical character and fineness of the mineral filter.
3. Consistency or penetration of the asphalt.
4. Proportions in which the sand, filler, and asphalt are combined.

**Durability Primary Requisite.**—Durbility is mainly dependent upon the following factors, of which the first two only will be discussed as being directly related to design.

1. Presence of sufficient asphalt to prevent undue weathering, and cracking by contraction.
2. Density of mixture, or resistance to water absorption.
3. Toughness of the sand grains, particularly of the larger grains.
4. Permanence in the characteristics of the asphalt.

Stability and density tests of compressed asphalt paving mixtures have been of great value, not only in working out the principles of design, but also in evaluating the factors listed. The results can be used by any testing engineer as a guide to correct proportioning, if a few basic principles are kept in mind. From the density test of the compressed mixture, the percentage of voids may be readily calculated, as well as the percentage of voids in the compressed mineral aggregate, exclusive of asphalt. Both of these calculations are important in designing mixtures.

**Determining Best Practical Formula.**—Unless one or more of the constituents is entirely unsuitable for use, it is possible to control stability, voids in the compressed mineral aggregate, and voids in the compressed mixture, by varying the proportions of the constituents. In obtaining the best practical formula for use with a given set of constituents, the following facts should be kept in mind.

1. The inherent stability of a compressed mineral aggregate increases as its density approaches that of a solid, or as its percentage of voids is decreased.
2. Mineral filler is an effective stabilizing agent, through its action in reducing voids in the total mineral aggregate, and in increasing internal frictional resistance by its relatively large surface area per unit volume.
3. Most mineral fillers in themselves contain a high percentage of voids. Their effectiveness in reducing voids in the total mineral aggregate is therefore limited, and their use in excess may defeat the purpose for which they are incorporated in the mixture.
4. Percentage of voids in the compressed mineral aggregate is not in any way related to percentage of voids in the total mixture, as the latter is largely a function of the amount of asphalt used.
5. The amount of asphalt that may safely be used is limited by the percentage of voids in the compressed mineral aggregate. Any excess of asphalt, which would tend to overfill the voids, will greatly decrease the stability of the mixture.
6. Assuming a satisfactory degree of stability to exist, the more asphalt

present, the greater will be the durability of the mixture. As the amount of asphalt is limited by the percentage of voids in the compressed mineral aggregate, it therefore follows that, when the desired degree of stability can be obtained with a relatively high void aggregate, greater durability is assured than with an exceptionally low void aggregate.

7. High stability is undesirable if obtained at the expense of durability, and great durability of the mixture is of little value if the necessary degree of stability is lacking. In designing, it is therefore often necessary to strike a balance that will insure the mixture possessing both characteristics to a reasonable extent.

**Standards of Stability and Durability.**—With these principles in mind, it becomes important next to consider standards of stability and durability that may be set up as a guide to intelligent design. Considerable investigation is needed to establish exact limitations for the various combinations of traffic and climate encountered in paving work, but some information of a helpful nature, along this line, is available.

Thus, studies have been made of a number of pavements under existing traffic conditions, with relation to their resistance to displacement as measured by the stability test. It has been found that, under heavy mixed traffic, such as prevails on Fifth Ave., New York, no appreciable rutting or shoving had occurred where the mixture developed a stability of 2,000 lb. or more, but that where the stability fell below 1,200 lb., displacement became quite pronounced. Other examples could be cited to support the establishment, as a guide at least, of a stability value of 2,000 lb. or more, for heavy mixed traffic, with a minimum low limit of 1,200 lb., except for light, rapid traffic.

In regard to durability, it is known that most of the older sheet asphalt pavements in satisfactory condition today contain 10 per cent or more of asphalt, although some have slightly less. It is also generally known that durability of a protective asphalt coating increases with the thickness of the coating, provided the asphalt itself is of satisfactory quality, and is properly applied. It therefore seems reasonable to set 9 per cent, by weight, of asphalt, as a safe low limit for paving mixtures subjected to severe climatic conditions, and to endeavor to design mixtures that will carry 10 per cent or more of asphalt, without an undue sacrifice of stability.

It has been ascertained that compressed asphalt paving mixtures, containing as high as 5 per cent voids, are reasonably unabsorbent and resistant to water and frost action, and as it is very easy to design a workable mixture containing less than 5 per cent voids, it appears reasonable to set this figure as the maximum. The increase in volume of asphalt in a compressed paving mixture at its maximum summer temperature, is less than 1 per cent of the volume of the mixture, but since, in its expansion, it is unable to drive all of the entrapped air out of the void pockets, it is felt that the low limit for voids should be about 1.5 or 2 per cent.

**How to Design a Mixture.**—Having established a rough guide for design, practical application of the principles developed may be quickly illustrated by considering the following problem.

Given one sample each of sand, mineral filler, and asphalt, can a satisfactory mixture be produced from these constituents for heavy traffic under severe climatic conditions, and, if so, what combinations will be acceptable?

In order to establish a field of values, the four mixtures in Table I are prepared and compressed for testing. In each of these mixtures, a lower percentage of asphalt is used than would probably fill all voids in the compressed mineral aggregate.

The specific gravity and stability of each of these mixtures are obtained, and the percentages of voids in each mixture, and in the mineral aggregate of each mixture, are calculated from specific gravity determinations previously made on each constituent. Two diagrams are then prepared, one showing stability plotted against percentage of filler, and the other, voids in the mineral aggregate plotted against percentage of filler.

The first diagram readily shows what proportions, if any, of sand and filler will produce mixtures of 2,000 lb. stability or more. Assuming that results are favorable, and that mixtures containing from 12 to 25 per cent filler show satisfactory stability, the next step is to ascertain what range in percentage of voids exists for these mineral aggregates. This is at once indicated by a second diagram, from which the weight percentage of asphalt to use for any combination, can be roughly calculated by subtracting 1½ from the indicated percentage of voids, and dividing the difference by 2.2. As a general rule, mineral aggregates that show less than 21 per cent voids, will carry satisfactorily not more than 9 per cent, by weight, of asphalt. If, therefore, satisfactory stability can be obtained, it is desirable to adopt a formula in which the mineral aggregate contains a minimum of 21 per cent voids, and preferably a minimum of 23½ per cent, in order to allow for the use of at least 10 per cent, by weight, of asphalt.

Assuming the diagrams to show that a stability of 2,500 lb. may be obtained with a mineral aggregate containing 23½ per cent of voids, but that higher stability calls for a lower void aggregate, it would then seem advisable to sacrifice additional stability, rather than to risk decreased durability from the use of too little asphalt. In any event, a formula having been selected, the final step is to prepare a mixture according to such formula, and test it for stability and voids, in order to check the preliminary work. Any desirable modifications will then be readily indicated.

Table I

| Mix | Sand | Filler | Asphalt |
|---|---|---|---|
| 1 | 90 | 0 | 10 |
| 2 | 81 | 10 | 9 |
| 3 | 72 | 20 | 8 |
| 4 | 63 | 30 | 7 |

In the first diagram we will see, where we have percentage of filler plotted on the horizontal, and pounds stability on the vertical scale, that anything over 15 per cent of filler will give us a stability value of 2,000 lb. and that the maximum stability value, in this case a little over 3,000 lb., is reached with about 24 or 25 per cent of mineral filler, after which the further addition of filler causes a falling off in stability.

If we plot the voids in the mineral aggregate, we find there is a reduction of voids in the mineral aggregate down to a minimum, after which a further increase in filler causes an increase of voids and a falling off in stability.

In the second diagram for stability, we would first ascertain that any mixture of from 15 to 24 per cent of filler would be satisfactory so far as stability is concerned. But we have the factor of durability to consider; and we know that durability is largely a function of the amount of asphalt present. And in the void curve, which we should have at the bottom of the diagram, we find that we have 22 per cent of voids, with about 23 per cent of mineral filler. Now we determine the amount of asphalt necessary to fill the voids, by subtracting our 1½ per cent and then dividing by 2.2, which shows us we have about 9 per cent of asphalt as what that mixture will probably hold. Now 9 per cent had been set as our limit for the low amount of asphalt in our mixture. We therefore run a line up to see where that cuts our stability diagram. The minimum stability, which is the governing factor so far as stability is concerned, is dropped down to the void curve, and we find we have a percentage of voids in the mineral aggregate of a little less than 25, which, allowing for a 1½ per cent void content in the compressed mixture, would allow for the use of 10.7 per cent of asphalt. We then have an area showing the combinations of sand and mineral filler that would produce satisfactory stability, and also give us an amount of asphalt we would consider satisfactory for durability. In other words, the mixture would hold from 9 to 10.7 per cent asphalt, and would show a stability of from a little over 2,000 lb. to almost 3,000 lb. That gives us an area within which to work.

Now if we had arbitrarily selected 10 per cent as what we considered desirable to use from the standpoint of asphalt, we would estimate from this diagram that the use of approximately

17½ per cent of filler, as shown by the circle on the diagram, requiring the use of 10 per cent, would be a simple formula to use. We would then, in order to check the indications obtained from these diagrams, make up such a mixture, and actually determine its stability and percentage of voids; and if they came within the limits, that is, if such a mixture showed a stability of over 2,000 lb., and a percentage of voids when compressed of not over 2 per cent, we would consider that mixture as satisfactory to use, and would also know that the limitations in variations of the percentage of filler and percentage of asphalt would be illustrated by that diagram.

It may happen that with a given set of constituents, satisfactory stability can be secured only with an undesirably low void aggregate. In such event, it is well to try out some other available commercial filler, which may produce quite different results with the given sand. In some cases, the sand itself may be incapable of producing mixtures of satisfactory stability, although it may pass all of the usual specification requirements for sand. The remedy then lies in substituting some other available sand that will produce the desired results.

The consistency or penetration of asphalt has some effect upon the stability of mixtures in which it is incorporated, but within the limits commonly used, less than one might surmise. Thus a 10-point difference in penetration will seldom make a difference of over 150 lb. in stability. If it is otherwise impossible to get the desired results, this factor can sometimes be utilized advantageously by selecting an asphalt of somewhat lower penetration than that employed in obtaining the original design data.

The purpose of this paper has been to put in tangible form and as briefly as possible, the principles of design in the light of most recent research. Full description of the tests to which reference has been made have been published by the Asphalt Institute together with the results of investigations dealing with various factors affecting design, and may be obtained by any interested person.

Acknowledgment.—The foregoing is a paper presented at a meeting at the Engineers' Club of Philadelphia.

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**Road Improvements in Nova Scotia, Canada.**—The Minister of Highways of Nova Scotia recently stated that $90,000,000 would be required for improvements to the highways of Nova Scotia during the next twenty years and that at least 1,000 miles of roadway in the Province would have to be paved. The Province at present has 14,976 miles of roads. Of these highways about 1,600 miles are classed as trunk roads, of which approximately 1,375 have been graded and surfaced.

## Efforts of States and Cities to Solve the Congestion Problem

Traffic difficulties of the cities and urban districts generally of the United States are similar, it is found by the National Conference on Street and Highway Safety, and likewise the problems of the suburban or metropolitan areas are closely alike. These ills arise largely from the fact that modern vehicular traffic is being handled on systems of streets or roads that were designed for the requirements of ten, twenty or more years ago.

Uniformity of state traffic laws and municipal ordinances, and the most efficient possible use of existing streets and roads, is pointed out by the Conference as promising the most effective results in removing serious phases of the traffic troubles. Permanent relief, however, requires a systematic study of traffic conditions, and in many cases a rearrangement and readjustment of streets and roads.

The Conference favors the formation of local traffic commissions, composed of public officials and citizens, acting with engineering assistance, for the purpose of making studies of conditions and recommendations for their improvement. These studies and recommendations, the Conference indicates, should be based on data gained through traffic surveys and such surveys should be kept up to date to meet changing conditions.

Traffic difficulties of the cities, and also of many of the metropolitan areas, are found by the Conference in substance to be due primarily to eight general causes:

1. Lack of a common plan of highway improvement upon which all agencies responsible for road betterments can devote concerted action.

2. Absence of centralized authority and responsibility for road improvement, due largely to division of authority. Under these conditions the development of a satisfactory highway system has been found in most communities to be difficult.

3. Reconstruction of the principal arterial routes which were originally built for light vehicular traffic.

4. Existing arterial routes between the cities and other expanding centers of population and traffic in the counties do not provide a sufficient number of main thoroughfares for the proper distribution of traffic.

5. Tendency of main traveled roads to converge and unite as they approach the central sections of cities, and creating serious problems of congestion.

6. Narrow surfaces on various sections of main arterial highways, and other obstructions to the free movement of traffic, such as grade crossings, bridges, and double parking.

7. Inadequately improved sections of main arterial highways, and absence of improved connections on important routes, resulting in partially disconnected systems of highways, and uneconomic, indirect movements of traffic.

8. Physical obstructions, such as rivers, railroad yards and industrial plants, which prevent direct routes and connections.

Almost every city in the country, it is found, is faced with a problem of dealing with a traffic condition within their own bounds and of securing attention to the question in the nearby suburban areas, frequently in another political jurisdiction. For this reason it is pointed out that the governmental agencies in the cities and their surrounding suburban districts that have jurisdiction over highways and highway traffic can with advantage cooperate in the establishment of a general highway development plan, and in carrying the plan into execution when finished.

In its consideration of the matter the Conference has found that an adequate study of a municipal area and its suburban districts requires a period of years and engineering guidance in order to observe the effect that the execution of a plan has on the distribution of traffic, and the efficiency with which it is served by a modern highway system.

Regulation alone will not solve the traffic problem, in the view of the Conference, but long range planning is necessary to relieve existing conditions of congestion and prevent future ones.

A sound city plan is not a haphazard performance of designing streets, parks and other necessities, but a coordinated design adjusted to the requirements of future expansion. In most cities new sub-divisions are springing up and crowding closer together. With the annual increase in the number of automobiles in use, the parking question is worrying the cities and towns more and more every year. But traffic regulations, essential as they are, do not, it is pointed out, produce more and wider streets, and do not stop the increase in the number of automobiles.

Of 24,000,000 passenger automobiles registered in 1929, about 18,000,000 were centered in and around cities. The Conference estimates that the blockade of congestion is costing in time and business lost a sum of $2,000,000,000 a year.

Cooperation of state, county and city authorities in making thorough studies of traffic conditions, and planning to prevent fresh traffic troubles and congestion in the future, is pointed out by the Conference as a pressing need.

Traffic commissions, acting under official direction, and composed where necessary of representatives of more than one political jurisdiction, is one of the practical means through which the Conference believes the problem can be effectively approached and handled.

# Uniform Street Sanitation Records

## A Progress Report of the Committee of the International Association of Street Sanitation Officials

WITH the recent formation of the Committee on Uniform Street Sanitation Records of the International Association of Street Sanitation Officials, the establishment of standard units of measurement and methods of reporting for street sanitation activities seems assured.

The real purpose of this project is to furnish the sanitation official with standards for measuring and controlling the work of street and catch basin cleaning; snow, garbage, and other refuse removal; and the disposal of all such refuse. As formally adopted by the committee, this undertaking is designed (a) to provide the sanitation administrator with the proper information to plan, supervise, and control the operation of his department; (b) to furnish him with a factual basis for preparing budget and appropriation estimates; (c) to supply him with a method of reporting his work to the public; and (d) to develop sufficient uniformity in reporting so that the administrator can compare his quantities, costs, methods, and results with those of other cities.

The Committee on Uniform Street Sanitation Records has already taken major steps to obtain this goal by the tentative adoption of certain basic principles and standard units of measurement.

This undertaking is really not a new one, for the International Association of Street Sanitation Officials has for some years been discussing this problem at the conventions and has appointed committees to work in this field. Similarly, the National Committee on Municipal Standards has been working in this phase of municipal government and in September, 1929, published a tentative draft of Units of Measurement for Street Cleaning, Refuse Removal and Disposal. This report was adopted in principle last October at the Jacksonville convention of the International Association of Street Sanitation Officials. For the first time, however, the association has sufficient funds and staff at its disposal for adequate research and to prepare a formal report. For this, credit is due the International City Managers' Association which is devoted to the committee a part of recent appropriations from the Julius Rosenwald Fund and the University of Chicago.

The chairman of this committee is Joseph J. Petranek, Commissioner of Public Works, Cicero, Ill. The other members are L. E. Dempsey, Greensboro, N. C.; W. G. Bank, Newark, N. J.; Mark B. Owen, Dearborn, Mich.; A. S. Tew, Mobile, Ala. In order to give a broader basis for the work, an advisory sub-committee has been created on which are representatives of the International City Managers' Association, the National Committee on Municipal Standards, the American Society of Civil Engineers, the National Municipal League, the American Society for Municipal Improvements, the Governmental Research Association, the American Public Health Association, and the American Municipal Association. Clarence E. Ridley, Executive Secretary of the International City Managers' Association and Secretary of the National Committee on Municipal Standards, is chairman of this advisory committee.

The presentation of the work of this committee will be one of the features of the next convention of the International Association of Street Sanitation Officials to be held at Louisville, Oct. 9, 10 and 11. The final recommendations and reports of the committee will not be completed for several months because of the complexity of the subject as well as the necessity of proceeding advisedly and with the continuous counsel of sanitation officials throughout the country. However, some of the basic units and principles tentatively adopted by the committee will be proposed for adoption at the October convention of the association. These include the following:

**Miles of Streets Cleaned.**—Research to date has led the committee to believe that the extent of streets cleaned should be measured on a curb-mile basis. Under present pavement and traffic conditions, the cleaning of streets is becoming largely a matter of cleaning along the gutter. If a machine is used the mileage will be determined by the actual miles that it travels along the curbline. If a flusher or hand method is used, the curb-miles on both sides of the streets cleaned will be totaled. To have a better understanding of the work performed when streets are cleaned by hand and flushing methods, special computations will be made of street width and amount of water consumed.

The main advantage of the curb-mile basis as compared with the square yard measure is that unit costs are not distorted by the width of the street. For example, the square yard cost of cleaning a street 60 ft. wide by running a motor sweeper up one curb and down the other would be half that of cleaning a 30-ft. street even though exactly the same amount of work was done on both streets. Comparisons of the cost of various methods of cleaning would be meaningless under such conditions.

**Tons as a Unit.**—"Tons of refuse" has been adopted as the standard unit for the removal of garbage and other refuse as well as for its disposal. In view of the impossibility of estimating cubic yardage and due to the variations in weight of garbage from one season to another and from one part of the country to another, weighing is the only reliable method of measuring quantity. However, where it is impossible to weigh even sample loads of refuse, which is generally the case where the refuse is hauled to a dump, the committee provides that "cubic yards" may be employed as an alternative unit.

Wherever possible the collection, supplementary transportaton if any, and disposal of refuse should be treated separately, but with sufficient uniformity that the figures may be thrown together and total costs computed for the entire process.

The committee recognizes that the removal of snow is not easily subjected to measurement. As a means, however, of knowing relatively how much work it requires the following units have been adopted:

(a) Number of miles of sidewalk plowed.

(b) Number of miles of street plowed.

(c) Number of cubic yards of snow actually removed and hauled away.

**Cubic Yards for Catch Basin Cleaning.**—Although the committee plans to use tons as the standard unit for refuse removal, it believes it desirable to make an exception for catch basin cleaning where cubic yards is the preferable unit. Whether eductors or hand methods are used, the cubic yard unit is much more desirable than tons, as it would prove impractical to weigh the cleanings. The committee recommends that separate costs be computed for both hand and machine cleaning.

**Computation of Costs.**—According to the committee's recommendation the computation of these standard units in terms of unit costs shall include the following items of expense:

(a) Personal services (to include all direct labor costs).

(b) Supplies and materials.

(c) Plant and equipment, including depreciation.

(d) Overhead, to be restricted to direct supervision and to exclude expenses not directly assignable to the operating division.

The committee finds that unit costs computed by the sanitation department without reference to the actual expenditures as entered in the general city accounts are likely to be inaccurate. As a result the classification of entries in

the departmental accounts from which costs are computed should correspond in so far as possible to the general accounting classification of the city. The total amount of expenditures used as a basis for unit costs can then be checked at least roughly with the general city accounts. Although even this will be difficult unless the accounts are kept on the accrual basis.

**Complete Instructions.**—According to present plans of the committee, its final report will include complete instructions with all necessary forms for computing quantities of work done and its cost as well as the means by which these computations can be converted into daily, monthly, and annual reports. For example, sample time cards, equipment records, and ledger sheets will be included as well as constructive suggestions for planning and controlling sanitation work.

In addition to its major report, the committee plans to devise a guide for the preparation of annual street sanitation reports analogous to the guide prepared for the police reports by the Committee on Uniform Crime Records. This guide will indicate for street sanitation officials what information should be contained in these annual reports and the most appropriate way of presenting it. This of course should aid in putting into use the standard units which the committee will prepare.

In order that the work may benefit from the advice of all interested persons, the committee is most anxious to obtain their suggestions and criticisms to the above units and program of work. Such communications should be addressed to Donald C. Stone, Director of the Committee on Uniform Street Sanitation Records, 934 E. 60th St., Chicago, Ill.

# Causes of Traffic Injuries and Fatalities

THE great number of motor vehicle accidents, resulting last year in the deaths of 31,000 persons and injuries to a million more, are due to a comparatively small number of causes and circumstances, virtually every one of which are preventable by the exercise of care and caution.

This is the finding of the third National Conference on Street and Highway Safety after a detailed study of the accident and fatality situation and the causes and circumstances that are involved.

Fifty-five per cent of the automobile deaths in 1929 were of pedestrians who were run down by automobiles. Available statistics indicate also that more than one-half of the accidents involving motor vehicles and pedestrians took place at street crossings and intersections.

These figures give a definite indication also of the places where safety activities and measures can be concentrated with the prospect of the largest measure of result. With pedestrian-vehicle accidents, "crossing the street at intersections" where there were no traffic lights or signals, and "crossing the street between intersections" are the most productive of injuries and deaths among all of the causes and circumstances that lead to or involve accidents on the streets and highways.

Reports of the police departments and motor vehicle bureaus of some of the states and cities of the country, covering a large number of accidents in 1929, and carefully tabulated and analyzed, showed that the number of injuries where the pedestrian was crossing with the traffic light or signal amounted to 4,244, while 37,681 were injured or killed while crossing against lights or signals or at crossings where there were no lights or signals. These figures are believed to reflect the general condition for the country as a whole, but covering only a fractional part of the accidents and casualties of this nature for the year.

The circumstances of pedestrian-vehicle accidents where the pedestrian was crossing the street at an intersection are found to be:

No signal, 27,177; against the signal, 9,022; diagonally across the intersection, 1,482, and with the signal, 4,244. Of this number, 1,438 were killed.

Accidents due to crossing the street between intersections caused the injury or death of 27,392 persons, while "playing in the street" caused the injury or death of 17,193 others.

In the list of accidents involving the occupants of motor vehicles, and not involving a pedestrian, are the following:

Exceeding the speed limit, 17,564; on the wrong side of the road, 16,842; did not have the right of way, 34,197; drove off roadway, 11,316; failing to signal, 9,159, and cutting in, 7,349. Among the 96,427 involved in these classifications, 3,820 were killed. Other causes, such as passing street cars, passing on curves and hills, improper turning and double parking, caused the injury or death of 10,808 persons.

Violation of the right of way was one of the most productive causes of vehicle accidents, caused in some instances by collisions between two cars where one of them had just previously been forced from the right of way by another car that escaped the accident.

The National Conference on Street and Highway Safety in its findings on this point, says:

"This demonstrates the need for adoption of definite right of way regulations as set forth in the Uniform Vehicle Code, and, furthermore, that enforcement and education should be particularly directed to such regulation.

"Another most frequent cause of such accidents is driving on the wrong side of the highway. This likewise points to the need of enactment and enforcement of restrictive measures requiring operation on the right half of highways.

"In a large number of motor vehicle accidents the operator drove off the highway and overturned. This illustratrates the need for enforcement of standard rules of the road requiring safe practices and particularly the need for education of motorists as to the hazards incident to operation at excessive speeds on curves or narrow embankments, or excessive speed for the conditions as they exist."

Safety education and the strict enforcement of regulations and driving rules is the recommendation of the Conference as a means of curbing and checking the accident and death toll.

The Conference points out at the same time that the adoption of the Uniform Vehicle Code by the states, and uniform traffic ordinances by municipalities, as sponsored and urged in the three sessions of the Conference that have been held, will go far toward reducing the accident toll.

Primarily, the adoption of such laws and ordinances will, in the view of the Conference and traffic experts of the country generally, serve to eliminate confusion among both pedestrians and motorists, whether at home or away from home.

Legislatures of the various states at their next sessions will have before them the Uniform Vehicle Code for consideration and adoption unless it is already in operation in a particular state. Cities likewise have the opportunity to amend their traffic ordinances to conform to the standardized and uniform provisions of the Model Traffic Ordinance of the Conference.

**Water Supplies Along Highways.**—The Ohio State Department of Health has located and plainly marked more than 200 small water supplies which may be found at reasonable intervals along the main highways throughout the state and advises all to use water from these in preference to the unmarked ones. In each instance a standard sign erected by the Highway Department indicates "Safe Water 500 Ft. Ahead." The supplies which have been found to be satisfactorily located and developed are further marked by a "Seal of Safety" that indicates safe water which is placed in plain view of the pump, if the development includes a hand pump. Where the supply is developed in such a manner that the water is under pressure and delivered through a faucet or bubbler, a certificate is issued, certifying that the water has been examined and found to be satisfactory. For the benefit of the stranger this is posted in a conspicuous place near where the water is obtainable.

# The Largest Highway Bridge in New England

## The Mount Hope Bridge Is 6,130 Ft. Long with a Main Span of 1,200 Ft. and Cost $4,250,000

ON Oct. 24, 1929, with historical pageants and other gala ceremonies, there was celebrated the opening of the Mount Hope Bridge, over Narragansett Bay, between Providence and Newport, R. I. This is the largest bridge in New England, built "to take the island out of Rhode Island." With the enthusiastic support of the financiers, every effort was made in the designing and building of the structure to make it "The Bridge Beautiful." These efforts were crowned with success when, on June 10, 1930, the committee of the American Institute of Steel Construction awarded the first prize to the Mount Hope Bridge, as being the most artistic steel bridge completed during the year 1929.

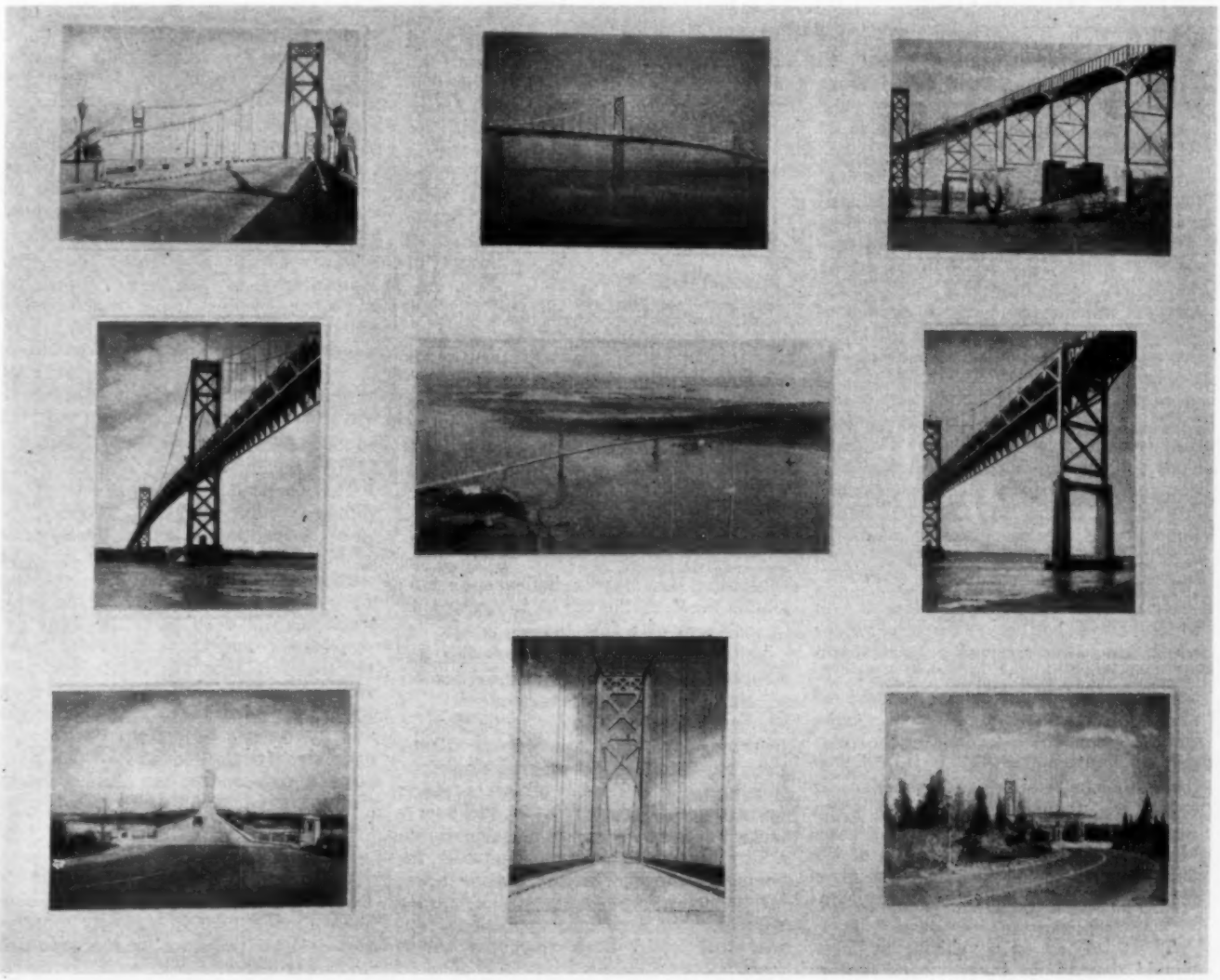
The Mount Hope Bridge, built at a cost of $4,250,000 to provide the shortest direct highway connection between Providence and Newport, is one of the most notable engineering structures in New England and has one of the longest spans in the world. The total length of the bridge is 6,130 ft.; the main span is 1,200 ft. long and 137 ft. in clear height above the water; and the main towers are 325 ft. high above the waters of Narragansett Bay.

The structure is of the wire cable suspension type, with graceful steel viaduct approaches on concrete piers. The main piers and the massive anchorage are faced with granite, and all the concrete work is finished with architectural paneling. Special attention has been given to the artistic design of the entire bridge and its approaches. Landscape and gardening treatment have been given to the bridge property at both ends, so as to enhance the distinguishing attractiveness of this crossing.

Construction of the bridge was commenced at the beginning of 1928 and record-breaking progress was achieved. The entire construction was completed in 22 months. The foundation men and steel erectors worked night and day in order to keep up with the record-breaking pace they had set themselves. The field organization employed on this work amounted to nearly 300 men. Fifty per cent of the work, including the most difficult foundation operations, was completed in less than one-third of the contract time.

The wire of the cables is approximately the thickness of a lead pencil, and each cable consists of 2,450 of these wires, laid parallel, to make up the circular section of 11 in. diameter. The two cables alone weigh 700 tons, containing 14 million feet of wire

The Mount Hope Bridge contains the longest steel girders that have ever been fabricated, erected and transported. These are 150 ft. long and are used for one of the viaduct spans at each anchorage.



View of the Mount Hope Bridge, a 6,130 Ft. Long, $4,250,000 Structure, Spanning Narragansett Bay Between Providence and Newport, R. I.

The central span of the Mount Hope Bridge is 1,200 ft. between towers. This is longer than the spans of the Hell Gate Arch Bridge and the Queensboro Bridge at New York, and is exceeded by only seven bridges in the entire world. The total weight of steel in the Mount Hope Bridge is over 8,000 tons.

The anchorage at each shore is a huge mass of concrete and granite encasing the anchorage steelwork. The Bristol anchorage weighs 18,000 tons. The concrete mass of the Bristol anchorage is below ground. The Bristol anchorage excavation into which the concrete was poured required the blasting and removal of 5,000 tons of bedrock granite. The Portsmouth anchorage is even more massive, weighing 27,000 tons.

The material employed for the cables of the Mount Hope Bridge is ordinary cold-drawn wire. The structure is proportioned and designed to carry safely the maximum conceivable highway loading—three lines of 20-ton trucks, closely spaced, extending over the full length of the structure from end to end.

The Mount Hope Bridge is a highway bridge, carrying automobiles and other vehicular traffic, also pedestrians. A complete system of ornamental lighting has been installed on the bridge and its approaches.

A most highly perfected system of toll-collection has been provided, permitting the simultaneous expeditious handling of four lines of vehicular traffic. Electro-mechanical devices for automatically recording the passage of every vehicle are one of the features of the toll-collecting system.

The bridge was designed by Robinson & Steinman, the consulting engineers of New New York City, who were also engineers on the construction. T. E. Blake collaborated on the architectural features including the approaches and toll house. The general contract was let by the Mount Hope Bridge Company, owners, to the McClintic-Marshall Company.

# Proposes New Tax Formulas for Adjusting Motor Vehicle Rates

WHEN you paid your last motor vehicle registration fees, did you stop to consider whether the amount was an equitable proportion of the total of taxes you paid for the use of the highways?

Charles F. Marvin, Jr., mechanical engineer of the U. S. Bureau of Standards, has worked out a simple method of distributing equitably the total motor-vehicle tax levy as determined by the State. Mr. Marvin's method apportions among the various classes of vehicles and among the units within a class tax payments corresponding as nearly as possible to the amount and character of the use of the public streets and highways by each vehicle. His system also includes a workable basis for levying fuel tax and registration fees. Results of his investigations are printed in the May issue of "Public Roads," the official research magazine of the Bureau of Public Roads, U. S. Department of Agriculture.

Mr. Marvin uses three formulas in which he substitutes certain values which have been arrived at after careful investigation of relative costs to the State resulting from operation of average vehicles of different gross weights and which allow for the relative economic and social desirability of the different weights of vehicles as units of transportation. The first formula is for the total of motor vehicle tax payments. Subtraction of the annual proceeds of the fuel tax gives the amount to be collected in registration fees.

The total tax on a vehicle, he holds, should depend on three major factors entering into the use of the highways—the weight imposed upon the road surface by the vehicle and its load, the number of miles it travels during the taxable period, and the type of tire with which the vehicle is equipped. So important in the matter of taxation is the gross weight of the loaded vehicle that it is a primary factor in Mr. Marvin's formulas. His formulas provide a gradual and consistent variation in tax throughout the whole range of gross weights.

As the actual gross weight of a vehicle varies with the number of passengers or the quantity of goods carried and also depends on the character of the equipment and the amount of fuel, oil and water in the tanks, it is necessary for the state to designate what the taxable gross weight of any given vehicle will be.

To distribute taxes fairly not only according to gross weight but also according to miles traveled, it is most equitable, Mr. Marvin believes, to collect as much of the tax as is reasonable in the form of a fuel tax.

Solid tires are considered more destructive to roads than pneumatics on a similar vehicle. Consequently, a somewhat higher tax for solid tires is justified, Mr. Marvin believes. These tires have little effect on fuel consumption and the difference must be made up in the registration fees. For registration fees he considers most equitable a formula which gives a gradually increasing difference in tax for the heavier vehicles, and suggests a higher value for the algebraic expression representing solid tires than for pneumatics.

According to the registration fee formula, the equation determines small fees for light cars, which are taxed equitably by the fuel tax alone, and is chiefly effective for the heavier trucks and busses, for which the fuel tax is inadequate.

Mr. Marvin's method of tax distribution permits a wide range of tax schedules to take care of the various classes of vehicles and is readily adaptable to the requirements of any state. The formulas may be modified to suit changing conditions, and without alteration of the basic method of rating vehicles or the system of collecting fees. He believes that for some years to come, the three factors—weight, miles traveled, and tire type—may be used as the basis for rating all vehicles and for determining fees in all States. However, it will not be reasonable to use the same amounts or ranges of fees everywhere and for all time. Costs of highway construction, the types of road, and the total mileages of roads, vary from state to state and from time to time.

In working out the formulas, Mr. Marvin has acted on the theory that an equitable tax system is one that will distribute the cost among the different vehicles in such a manner that each vehicle is assessed according to the justification for taxing. He believes the greatest justification for taxing is to defray the expenses incurred by the State as the result of the operation of motor vehicles. The first approximation to an equitable system, he assumes, would be one which would tax each vehicle in proportion as that vehicle is responsible for these expenses.

Taxes should also be imposed, Mr. Marvin says, so that they will penalize, wherever possible, those vehicles which are inefficient in their use of the highways of the nation's fuel resources. Each state must determine for itself how much it wishes to spend on highways and what percentage of this amount should be financed by motor vehicle taxes.

The fuel tax possesses several advantages over registration fees, chief of which is that it automatically taxes a vehicle directly in proportion to the number of miles traveled. It brings more revenue per mile from the heavy truck than it does from the light passenger car, and taxes the fully loaded vehicle more than the empty one. The vehicle that is overweight, overpowered, and which has an inefficient engine and improperly adjusted carburetor, or excessive friction in any of its parts, pays a higher tax per mile than the well-designed and well-cared-for vehicle of the same capacity.

**Canada to Spend $87,000,000 on Roads.**—More than $87,000,000 is being spent during 1930 on highway construction and maintenance by the provincial and local governments, with the largest outlay in the Prairie Provinces.

# What An English Highway Engineer Must Know

## Requirements and Questions at a Recent Highway Engineering Examination of the Institution of Highway Engineers of Great Britain

TWICE each year the Institution of Highway Engineers of Great Britain holds a highway engineering examination for those wishing to become members of the Institution. The examination is of two days' duration, one day upon test papers, and the other upon practical work, which may be based upon any subject in a syllabus. The successful candidates are awarded the viarumur on parchment, under the seal of the council of the Institution, and their names are published in the "London Gazettee" and the principal British technical journals. As members of the Institution fill the higher positions in the highway engineering field in Great Britain the examination may be of interest to American engineers in showing the requirements considered necessary to fill these positions.

**The Syllabus.**—The syllabus upon which the examination is based contains the following sections:

Section A—Surveying and levelling of highways and bridges, setting out of culverts, roads, bridges, corners and curves, super-elevation, surveying and levelling for land drainage, setting out lines and levels for surface-water drains.

Section B—Bridges, culverts and retaining walls, masonry, girder and reinforced concrete bridges, design, loading, testing, and maintenance. Design and construction of retaining walls. Temporary bridges. Geological aspect of clays and subsoils, sand, gravel and flint, granite and limestone quarries, working of the same, transport, machinery, and appliances. Tunneling, boring and blasting.

Section C—Excavations. Foundations. Road surfacings and maintenance. Asphalt. Bitumen. Natural asphalt. Asphaltic oils. Distillation. Consistency. Fluxing. Rock asphalt. Asphalt powders. Mastic asphalts, mixing and laying. Asphalt macadam. Sands. Fillers. Mixing, laying and rolling. One, two and three course work. Slipperiness. Clinker asphalt. Bituminous macadam. Testing of asphaltic and bituminous materials.

Section D—Wood block, granite and concrete roads. Laying out. Foundations. Expansion joints. Asphalt, rubber, brick and concrete block pavings and laying. Pitch, tar and bituminous grouted limestone, gritstone, flints, granite, slag and clinker pavings, and maintenance. Water-bound and silica-bound and cement-bound rural surfacings. Road rollers and their application, running and maintenance. Concrete, macadam mixers, machinery, asphalt heaters and mixers.

Section E—Pneumatic and electric roadbreaking machinery and drills, excavators, borers, and all classes of machinery and vehicles used in highway engineering. Footpaths, crossings, refuges, signs and signposts, road classification, zoning, traffic census. Estimating and specifications, contracts, works supervision. Bookkeeping, accounts, reports, costing and storekeeping, etc. Draughtsmanship. Maps, plans, sections, elevations, graphs, charts.

Section F—Building construction with relation to temporary and permanent depot buildings, structures, and workshops, storesheds, etc. Photography and photographic surveying, stationary and aerial. Highway law, including Private Street Works Act, 1892, Buildings in Streets Act, 1888, sections of Public Health and Housing Acts, having relation to highways, and their administration, depending upon center of examination, and Acts operative.

Section G—Town planning with relation to highway engineering. Such parts of sewarage that are superficial and relate to highways, etc. Cleansing, scavenging, snow-clearing, tree felling and planting, roadside waste and roadside depots and their maintenance. All other subjects applicable to Highway Engineering.

**Practical Questions.**—The Examining Board of the Institution does not strictly follow examination procedure of other municipal and engineering examination authorities, and candidates are expected to pay special attention to the practical side of the examination, as the examiners may give candidates some of the following:

(a)—Concrete mixer, materials, and gang of men, and the candidate will be required to organize and set to work such unit, in such manner that maximum output and efficiency is attained.

(b)—Gang of men, plant, and tools necessary to the construction of a reinforced concrete road to a plan supplied to the candidate, who will be required to lay out work, organize the gang to lay and screed the material received from (a).

(c)—Bitumen and asphalt mixers, men and tools, etc., will be placed at the disposal of candidate, who will organize the work of laying a 2-in. asphalt carpeting, as a further progression of (b).

(d)—Kerbing and foot path materials, and workmen, tools, etc., are supplied to the candidate, who will set out work to a plan.

(e)—Tar-spraying machines, men, materials will be supplied to the candidate who will organize and direct the work in hand.

(f)—Certain repairs are to be done to a bridge, to a plan, and candidate is supplied with men and materials, and he is then required to organize and efficiently commence the work.

(g)—Following a recent gale, a large tree has fallen across the main road, candidate is given men and plant at his own request, and he is required to show how he would set the men to work and remove the obstacle with speed and greatest efficiency.

(h)—Candidate is provided with assistants and instruments, and he is required to survey a typical stretch of roadway, after which (later) he is required to plot and draft a plan, with a longitudinal levelling, with four cross-sections.

(i)—A quantity of materials have arrived at the station or depot, the foreman having put aside samples and the candidate is required to accept delivery or otherwise, in accordance with a simple specification which will be handed to him, after he has defined the different classes of material examined upon.

(j)—Men, roller, plant and surfacing materials are provided, and the candidate must commence the work in efficient manner.

(k)—Men have been at work for one day upon certain classes of work, such as ditching and surface water draining, siding or skirting, pothole patching, road scavenging, and other works of highway maintenance, and candidate is required to determine between good and bad workmanship.

(l)—Candidates will be taken into the drawing office and given different tasks typically of every day occurrence in a highway engineer's drawing office, and the examiners will adjudicate upon the manner such work is commenced, and upon the progress made in the time engaged upon the work given.

(m)—Certain main road corners require super-elevation and the candidate is provided with essentials, and instructed to lay out the requisite work necessary to attain the above.

(n)—Candidate is given plan of certain roads, and required to submit a report upon building lines and other information for the joint town planning authority.

**Examination Test Questions.**—The last examination was held on June 20, 1930. The test questions asked at that time were as follows:

Section A. Test Questions

(1) Describe with sketches, how you would proceed to peg out the levels of a new road, which is 30 feet wide, has a gradient of 1 in 9, and is curved to a radius of 700 feet.

(2) A roadway is horizontal, adjacent land on each side is higher except on one side, near to the center of the section where a sewer crosses the roadway. The section is 500 feet long, and you are required to fix gullies at intervals, and drain the section into the sewer. How would you proceed to do this?

(3) Describe the dummy level, and how you would proceed to test its accuracy, and adjust the same for ascertained errors.

(4) A bye-pass new road is to be constructed, and part of such must pass through a hill, which necessitates tunnelling for about 340 feet, such being curved to a radius of 500 feet. As both ends of the section are practically level, how would you survey, and set out lines requisite to proper formation and ultimate efficient drainage of the tunnel?

(5) Describe the theodolite, and tacheometer as applied to the survey of highways and setting out of bridges.

(6) Give a specimen page of (a) simple road survey (b) levelling of such survey, and by means of graphic sketches show how you would commence to plot plan and section from the specimens.

All the above questions may be attempted, but candidates must attempt at least three questions, and the marks awarded will be based upon the three best answers, and 60 per cent of maximum marks, will achieve a pass in this section.

Section B

(1) There is a slight subsidence near the haunches of a brick bridge, of approximately 30 feet span and 16 feet width, state what procedure you would adopt in testing such bridge.

(2) Design a retaining wall, in light loamy soil, in a 20 foot cutting, where the original gradient was 1 in 6.

(3) State the procedure you would adopt, and what essentials would guide you in the establishment of a flint and gravel pit.

(4) A tunnel is to be cut for an underground roadway, approximately 90 feet below the surface, 16 feet wide, flat bottom, circular sides and roof, state how you would commence the work of driving a tunnel through ragstone or similar strata, using blasting by electrical detonation, pneumatic air drills, and I. C. haulage, etc.

(5) Several acres of land have been acquired for the working and production of sand and shingle. State what plant would be required. Describe and show by sketches how you would establish and work such plant, together with details of how you would introduce washing and crushing plant.

(6) Bank (A) is 26 feet above water level, and bank (B) is 30 feet, and the river is 66 feet wide. Roughly design and give the dimensions of principal members of a combined timber and steel bridge 18 feet wide, loaded 15 cwts. per square foot.

Section C

(1) A roadway is to be made through the fen district, the bearing capacity of the soil being 25 cwts. per square foot. Describe and show by a cross-section how you would construct an 18 foot Main Trunk Road under such conditions.

(2) What is asphalt, describe how it is made, laid and maintained. How is asphalt tested, and what machinery and plant would you require for its manufacture and laying?

(3) What in your opinion is the best means to obviate slipperiness in asphaltic surfacings? Give costs and data.

(4) What is bituminous macadam? How is it made and laid? Give a condensed specification applicable to such work.

(5) Describe how you would organize plant and manual labor for the efficient tar spraying of a Class A main road. Briefly sketch and describe a mechanical tar-sprayer.

(6) What is bitumen? Tar? Pitch? How would you test these materials?

What grade of bitumen would you use for grouting of patches in waterbound roads, and tarmacadam surfaces, granite setts, etc.?

All questions may be attempted, but not less than three. Marks will be allotted upon the three best answers given, and 60 per cent of maximum marks awardable will achieve a pass.

Section D

(1) Describe and give a sketch of a modern wood block surfacing and how such is maintained. Give an estimate of cost.

(2) Describe how you would design and construct a reinforced concrete main road about 30 feet wide, showing particularly how you would organize your men and plant to attain the highest output and efficiency.

(3) Describe how you would construct a tar

grouted flint road, and give data of costs of the various items of the same.

(4) Describe and give costs of a cement-bound granite roadway. For what particular class of traffic is such a road suitable? In what particular manner would you maintain such a road?

(5) Describe a modern road roller, its maintenance and running costs. To what other uses can a road roller be efficiently put?

(6) Describe a concrete mixer, a tar-macadam mixer, an asphalt mixer and state what special precautions are necessary in order to obtain a satisfactory product.

(7) Design a screed for laying concrete with a cross-fall of one in forty. Describe how you would tamp the concrete to a finished surface, and harden such surface.

(8) What is an expansion joint, and where is such used? Describe by what means you would provide such joints. What expansion joint would you use with wood block surfacing?

All the questions may be attempted, but at least four must be answered. The marks will be allotted to the four best answers, and 60 per cent of awardable marks will achieve a pass.

Section E

(1) Describe an efficient unit of either pneumatic or electrical road breaking plant, and define how you would organize your men to achieve a maximum output.

(2) Describe any form of mechanical excavator for excavating earth for roadmaking, and describe any tool which will bore holes efficiently for erection of concrete or other fencing.

(3) Describe how you would organize a traffic census in a town where five main roads emanate from the same. Sketch a typical census sheet applicable to such work.

(4) Describe the principle of any form of electrical traffic controller, and its initial cost and maintenance.

(5) A roadway is to be surfaced with 3 in. of tarred slag, sealed with tar and dusted with slag dust. Give a specification, quantities and estimate, and state how you would organize your haulage, plant and men for efficient execution of same.

(6) What books are necessary in highway accounts and costing, and store keeping? State what procedure you would adopt in order to obviate inaccuracy in returns and costs.

Section F

(1) What is photographic surveying, and how is such applied? When would you obtain the best advantages of an aerial survey? Give the limitations of photographic surveying as applied to highway engineering, and town planning.

(2) Give a sketch of a model depot of a highway department, and enumerate the machines and plant that you would install for an area containing 200 miles of main road, and 400 miles of district roads.

(3) What is "misfeasance"? What pointers would you give to your staff and workmen, to obviate any action at law for negligence? What action would you take where a timber convoy cuts up the highway, and you have reason to think that the tractor does not conform with statutory requirements?

(4) Describe the Road Improvement Act 1925. How would you proceed to establish building lines adjacent to main roadways? Describe the necessary statutory procedure.

(5) Road surfacing and lengthy highway works are to be done at an isolated district. State what temporary erections and accommodation is necessary for plant and workmen, cement, etc.

(6) The excavated material from a cutting has to be transported over a main road to a valley to form an embankment. Sketch and describe how you would efficiently achieve this.

In each of the above sections E and F, all questions may be answered, but at least three questions in each section must be attempted. Upon the three best answers the marks will be allotted, and 60 per cent of the maximum awardable marks will constitute a successful pass in each section.

Section G

(1) In what manner will highway engineering affect town planning? Give a typical cross-section of an arterial roadway that is usually constructed in relation with a town planning scheme.

(2) Give sketch and describe the road drainage of a main road from the gully grate to the sewer. Describe and sketch a manhole capable of withstanding main road traffic.

(3) Describe how you would efficiently scavenge and cleanse the roadways and streets of (a) a large city, (b) a small urban authority, and (c) a parish.

(4) A heavy snowstorm has blocked up the main and district roads and traffic is held up. Describe what plant and labor you will require, and what method you would adopt, and how you would organize your plant and men, to efficiently clear the roads in question.

(5) Describe how you would fell and remove different classes of trees on each side of a main road where widening is projected. State what trees you would plant upon the margins of a main arterial road, keeping in mind the cost of maintenance.

(6) What in your opinion is the best means of laying down white traffic direction lines and signs, and their maintenance.

## To Eliminate Loose Credit Practices in Construction Industry

Presenting a united front for an intensive nationwide campaign to eliminate loose credit practices throughout the building construction industry, the Associated General Contractors of America, the National Builders' Supply Association and eight nationally organized trade groups of subcontractors have joined hands to launch the Allied Building Construction Industries for cooperative utilization of both selling and buying power in the enforcement of standard credit policies.

Meeting last month at Cleveland, representatives of the various groups agreed upon the necessity of intensifying and coordinating efforts in promoting and launching credit bureaus in every city of the nation, and ways and means to create a sound, permanent credit structure within the industry were laid.

A detailed standard program for promotion and operation of the credit bureaus is to be worked out by a committee composed of Edward J. Harding, assistant general manager of the Associated General Contractors of America; Frank Dunning, of Cleveland, representing the National Builders' Supply Association, and Edward McDonnell, of Detroit, representing the Contracting Plasterers' International Association.

Mr. Harding explained that the basic principles underlying the credit stabilization movement which will guide his committee in the drawing up of programs for standard procedure, are the same as those now being successfully applied in Detroit, Memphis, Los Angeles, Milwaukee and other cities, with the additional feature of having the Bureau of Contract Information, Inc., Washington, act as the national clearing house for delinquent account and interchange information.

Features of the plan, Mr. Harding said, are the establishment of agreed upon standard credit terms, including an automatic credit cut off date, by joint groups of buyers and sellers concerned with each trade group in a city; the organization of a central credit bureau in each city under the joint control of the various groups participating in the movement; the collection of reports on all delinquent accounts from the various selling groups; the issuance of a monthly statement showing the consolidated reports of delinquent accounts as gathered; the cooperative support of the standard terms by both buying and selling groups; and the submission of copies of each monthly delinquent account report to the Bureau of Contract Information, Inc., at Washington, for subsequent redissemination on a national interchange basis.

Among the important details yet to be worked out, Mr. Harding stated, are the matters of financing and of training the needed promotional executives. One proposal being considered contemplates the creation of a joint treasury to finance the initial promotional expense, which would be repaid to the national joint revolving fund when once the local association was launched and self-supporting, he explained.

In addition to the Associated General Contractors and the National Builders' Supply Association, those participating in the movement are the National Association of Building Trades Employers, Mason Contractors' Association of the United States and Canada, Contracting Plasterers' International Association, Tile and Mantel Contractors' Association, National Association of Sheet Metal Contractors, United Roofing Contractors of America, Heating and Piping Contractors' National Association and the International Society of Master Painters and Decorators.

## Highway Transport Library Organized

Announcement of the organization of a library on highway transport has been made by Thomas H. MacDonald, chairman of the Highway Education Board and chief of the United States Bureau of Public Roads. The library will be for the use of engineers, economists and others interested in highway transportation and related questions.

There are few such libraries and the establishment of one in Washington will be useful to persons in the United States and will also be of great value to visitors from Latin American and other countries, who will have an opportunity of gaining access to the latest works on the various phases of highway transport. Not only books, but magazines, brochures and pamphlets will be available.

A special feature of the library will be the Latin American section, where books and magazines in both Spanish and Portuguese will be at the disposal of visitors from Central and South America. Work in building up this section of the library has been going on for some time preliminary to the actual organization of the library, it was announced, and thus this department will be well organized from the start.

The library will be open to all persons desiring to make use of its facilities.

# Improving Conditions in Highway Construction

## Prequalification of Contractors—Eradication of the Incompetent and Inadequately Financed—Better Bonding Practices—and Better Engineering Designs

By THOMAS H. MacDONALD
Chief, Bureau of Public Roads

YOU have asked me this question: What constructive steps have been taken to improve conditions in the production of public works, with particular reference to the production of highways?

The apparent attitude of the public, so far as I have been able to understand it in years of public service, is to demand contractors and engineers who can satisfactorily complete public works contracts, within the specified period and at reasonable prices. We approach neither of these two desirable ends by talking in a general way and so I will confine my remarks to a few specific propositions.

**A Billion Dollar Expenditure.**—In the years of Federal Aid since I have been connected with the Bureau of Public Roads, we have had something over 18,000 projects, involving more than that number of separate contracts. Practically all of these contracts have been satisfactorily completed. There have been very few, proportionately, that were not satisfactorily completed in the end. We have paid out over $800,000,000 for Federal Aid highways and bridges through the States; more than $68,000,000 for forest highways; and $11,000,000 for National Park highways, through the organization of the Bureau. With an expenditure totaling nearly a billion dollars, we feel that we know something about contractors and their methods. It is a pleasure to be able to say there prevails throughout our organization an appreciation of the work and of the service that the contractors have given to the production of public roads in the United States; and further, without the hearty cooperation, loyalty, and spirit of public service that the contracting industry has put into this business, we would not have been able to make the progress that we have.

So that on the whole, my message is one of gratification and congratulation to the contracting industry, including both the material and the equipment men, as we all have a great appreciation for the remarkable development of modern construction equipment which has taken place.

**The Causes of Unsatisfactory Progress on Contracts.**—We receive each month from our districts, which cover all of the United States, a statement as to Federal Aid projects which are unsatisfactory—on which progress has not been such as to complete within the time limit. For the present fiscal year, the cumulative reports show that the reasons for unsatisfactory progress, as detailed by our engineers in the field, have been:

| | Per Cent |
|---|---|
| Labor shortage | 0.5 |
| Materials | 1.2 |
| Inadequate equipment | 8.2 |
| Financial | 1.1 |
| Management | 52.7 |
| Weather | 26.4 |
| Construction difficulties | 6.0 |
| Cause not stated | 2.6 |
| Preliminary difficulties | 0.3 |
| Legal | 1.0 |

As you see over 75 per cent of the reported reasons for unsatisfactory progress revolve around the two items of management and weather. One of these can be largely controlled, while no contractor can entirely eliminate some of the weather vicissitudes. In approaching the question, this report in summary perhaps does not absolutely accurately detail the real reasons for delay in completion of work, but we regard it as reliably indicative.

There are two or three different lines of endeavor we have been promoting which we feel are directed toward the elimination of some of the difficulties of management, and may extend to obviate some of the slowing down due to the weather causes. I refer, first of all, to this matter of prequalification of bidders.

**The Competition of Efficiency.**—As one of our engineers suggested, the right to bid on public works seems to be a matter that the public feels is an inherent right of citizenship, along with the right to vote; and that any public official who dares to take the stand that a contractor ought to be reasonably qualified to perform before he bids upon a contract, large or small, is in some way entering into an intrigue to stifle competition. There can be no competition of inefficiency and efficiency, or between inefficiencies, that is helpful to the public. The only competition that can be helpful to the public is the competition of efficiency. And in the forest road work, and in the National Park road work we have for three years prequalified the contractors. The details have been well reported at other meetings, and I do not intend to go into the subject at any length. But I give you the results of the last two years.

**Prequalifications of Contractors.**—In 1928, we had 193 applications for prequalification blanks; and from that number qualified 189. The truly wholesome effect of this qualification of bidders seems to be that the man who is not financially qualified or properly equipped to conduct a contract comes to that realization when he quietly faces one of the prequalification blanks before he has put in a low bid. In the old days, as you know, the awakening came sometimes after making the low bid. Neither he nor the public official knew what to do about it, because after a low bid is once recorded in the minutes of the public body and repeated in the press, the public looks upon it as a nice juicy plum just within reach. If the public official takes it away by saying, "This man can't do the work at these prices—can't possibly do the work at these prices," the public mind at once is turned questioningly toward his veracity. So the public official in self protection hesitates to turn down the low bidder. Consequently, he is in a much better position if he never receives an unreasonably low bid than to have it entered on the record. There will always be those who feel, "Well, maybe we could have gotten satisfactory work at those prices," regardless of their impossibility.

So the important point to prequalification is that the man who would bid upon work faces the issue of responsibility before, and not after he has put in his bid. This seems to be all of the limitation of competition that is involved. In 1929 we had 276 applications for blanks, and qualified 262. In other words, in two years, only 18 applications for prequalification were turned down; which was less than 4 per cent of the total number who applied.

With this record, I believe no one can truthfully say that prequalification limits competition. As I remarked before, there can be no competition that is of advantage to the public when inefficiency with inadequate equipment and inadequate financial resources is placed in competition with efficiency, adequate equipment and financial responsibility. The public would never benefit from competition of inefficiency with efficiency and the awarding of work to the inefficient contractor rather than the contractor who can and does satisfactorily perform his undertaking.

After prequalifying contractors, we received in 1928, 470 bids—1929, 393 bids. The average number of bidders at each letting in 1928, was 4.7, and in 1929, 5.4. In other words, five contractors bid for each job in each of the two years. There was only one default in each of the two years. In 1926, the

first year preceding prequalification, we had six defaults. It seems to me that on the basis of the facts as I have given them, we need no other arguments for prequalification. We have also pretty well exploded, with the prequalification experience, the idea that any contractor who can furnish a bond is a properly equipped contractor.

**Contractors' Bonds.**—In common with many other public officials, I had reached the point several years ago of doubting whether we ought to continue to demand contractors' bonds. That is, we had come to the point where we were about ready to break away from the old established idea that the public should be protected by surety bonds, and to set up some other form of protection that would be less abused. There are today some conditions which are to be eliminated. May I say to you contractors assembled, that no contractor taking a Federal Aid contract has to take a bond from any particular company in any state in the Union. We occasionally get information that agents of bonding companies are trying to control contracts. They cannot control Federal Aid contracts in that way—if we know it. And I believe that the contractors ought to have enough back-bone to pass the information along to us if any attempts of this kind are made.

The best movement that has taken place to reinstate contractors' bonds to a favorable position in the minds of public officials is the establishment of the Bureau of Contract Information, under the general auspices of the Associated General Contractors. We will make progress by getting the facts, by the work that will be done through this bureau, and I am very much pleased with the support that this work is receiving from those who are in the position to give contract information in detail.

It seems to me that with the facts which are collected and made available through this bureau to the public official and others entitled to them, we will eliminate the inefficient contractor to a considerable extent and will help to stop some of the practices which very nearly destroyed public faith in contractors' bonds themselves. As I say, there are still some spots to be cleared up in that field, and I only hope that the contractors will, through their own bureau and in other ways, help to weed out practices that are bad.

For example, we have a suit pending against us right now, brought by a bonding company on some work conducted by the Bureau of Public Roads in the days before pre-qualification. It was in the days when every contractor who could get a bond was a qualified contractor. We didn't want the contractor—he was not a real contractor, he had neither the equipment nor the financial backing to support the job. He was able to induce a poor fellow to go into partnership with him and supply some financial backing, and had a bond written by the company which is now suing the government, through an agent whom it had expressly forbidden to write the bond. So, the bonding company, through the act of the agent, gave itself a contractor that it did not want, and gave the Bureau of Public Roads a contractor that we did not want. Nobody was pleased, unless it was the agent who got the commission on the bond, and as far as I know, he is the only one who made any money out of the deal.

And so, when I speak of bonding practices, I am not speaking of practices which may be ordered by the bonding companies themselves. There are bad practices which grow out of a failure to control the agents. The companies who issue bonds are responsible for their agents and must bring them under control. While there is no criticism of agents who earnestly pursue the business of writing bonds, we do not want these same agents engaging in the contracting field in attempts at political manipulations or otherwise blocking public officials in their efforts to conduct public lettings in a clean cut and wholly fair manner.

**Construction Management Studies.**—In the setting up of the management studies being conducted under Mr. Allen of the Bureau of Public Roads we have taken a step that will be helpful in establishing better relationships between the contractors and public officials and their engineers. The Bureau established these management studies with the idea of training young engineers to a greater understanding of the difficulties of production and the adequate methods by which to produce work to secure a supply of such men to feed our engineering organization. It has been a time honored custom, as you know, to start the engineer at the end of a transit and level or pulling a chain, or over a drafting board. We have rather reversed this idea, and are starting our young engineers in the field, studying in cooperation with the contractors and the engineers in charge of the work the production of each part of the work in relation to the whole.

So we start our young engineers, each year, in the business of studying the production of roads and the contractural management. Referring back to these causes for inadequate progress on Federal aid projects, management is listed as bearing the burden for over half of the slow or unsatisfactory progress.

Each year we pick out from the colleges twenty or thirty young men and, in cooperation with contractors who are interested in studying their own organization, we place these young men on the job to study each operation; to study the equipment relative to the key equipment on possible production. For example, in concrete road production, the amount of concrete that the mixer can produce is considered the key to the plant production. We estimate the amount of concrete that can be put through the mixer with efficient management and against this measure the progress in all parts of the work.

**Idle Equipment.**—Some of you know of the results but it may surprise some that in a very careful study of more than 100 concrete jobs, we found that the contractors' equipment, due to major delays, that is, delays above 15 minutes each, was idle 40 per cent of the time. This was due to major delays, and take account only of the time elapsing after the crew was on the job and equipment assembled and ready to work. We found further that the second class of delays, the minor delays, amounted to another 16 per cent of the time. So you see that today the bids really are necessarily based on somewhere around 50 per cent of the efficiency of the key equipment.

This does not mean that we are able to get 100 per cent production; so it is not fair to use such figures to say that the contracting industry is only 50 per cent efficient. For example, just to illustrate the matter of major losses on concrete road production.

**Causes of Delay.**—Rain accounted for 9½ per cent—this is an average for about 100 jobs, which varied all the way from inefficient jobs up to jobs that ran 90 per cent efficient, and wet subgrade 8 per cent. You see, there is 17½ per cent that probably could not be avoided. Lack of prepared subgrade—which could be avoided, 3 per cent; lack of materials, which could be avoided, 3½ per cent; moving plant set-up, 3½ per cent; inadequate supply and faulty operation of hauling equipment, 3 per cent; mixer trouble, 2 per cent; lack of water at mixer, 2 per cent; loading plant trouble, 1½ per cent, miscellaneous causes, 4 per cent; a total of 40 per cent, all exacting delays more than 15 minutes each in length. I am not going into that subject further. I am only giving you this as indicative of the policy which we are pursuing, of attempting to feed men into the engineering organization of the Bureau of Public Roads after a training on production.

You will find through my talk that there has been no attempt to say that the engineer is perfect and the contractor is always wrong. We knew that while there may in some cases exist a feeling, sometimes on one side and sometimes on the other, that the other side is one hundred per cent wrong, after all the causes of difficulties are probably about equally divided. For example, until we started these management studies, we had not appreciated—and I confess it with some chagrin—that we may design a road so that the contractor with proper equipment can produce efficiently, or we make it impossible for him to use his equipment—any given equipment, effi-

ciently. That is, we may design the cuts and fills so that the length of hauls so vary from day to day, that the number of wagons necessary to keep the shovel busy one day may be too many or too few the next. The contractor then is bound to compromise, and to have his whole equipment operating something under its efficiency, due to poor design by the engineer.

**Designing for Efficiency.**—We cannot charge such results to the contractor if the engineer does not design the work so that the contractor can, with any given equipment, build efficiently. We have a long way to go in the engineering field to design with efficient production in view. All of these matters reach into important possibilities of reducing costs of public works production. Each of these—the prequalification of contractor; the eradication of the incompetent, inadequately supported contractor; better bonding practices that we are getting through the information supplied through the Bureau of Contract Information; the study by the engineers of their design for proper execution by the contractor; and the bringing of men into the engineering field who know the contractors' problems, sympathize with him, and can be helpful in solving them, are important advances toward better public service. These thoughts are expressed as the thoughts which we have with us all of the time in the conduct of this Federal Aid work. We appreciate that with the increase of $50,000,000 in the Federal appropriation for this year we must have the friendly and vigorous cooperation of many more contractors than we have had before. We hope for attractive prices, of course, but we want to get these prices attractive to the public through efficiency of production, and not through loss to the contractor, or by throwing the work back on the bonding companies to complete.

Acknowledgment.—The foregoing is an address presented at a meeting of the Executive and Advisory Boards, Associated General Contractors of America.

## Grubb Made Executive Engineer County Officials Division A. R. B. A.

To efficiently carry out a great program of work for county roads during this year the American Road Builders' Association announces the appointment of Charles E. Grubb, former county engineer of New Castle County, Delaware, as executive engineer of the Association's county highway officials' division.

The division is increasing its efforts toward efficient financing, planning and administration of highways in all counties. The program of work among county highway officials this year by the American Road Builders' Association includes study of the question of financing county highways by the states; the elimination of unimportant highways and the re-location of secondary highway routes for greater efficiency and safety; the best methods of construction and maintenance of low cost roads and bridges; the re-surfacing and widening of highways which are inadequate for present-day traffic; the maintaining of earth and traffic bound roads.

Charles E. Grubb, New Executive Engineer, A. R. B. A.

In his new work Mr. Grubb will travel extensively throughout the United States conferring with county and township highway officials in regard to these problems. He will particularly concentrate his efforts on states in the middle West and the Mississippi valley, where great state-wide road programs are under way.

His work during the next few months will be in developing a comprehensive program of reports from county officials' committtes, which will lend added importance to the annual meeting of the county officials' division during the 1931 convention and road show of the Association to be held Jan. 12-16 in St. Louis, Mo.

The county work in the Western states will have the close attention of Stanley Abel, district supervisor, Kern county, Taft, Calif., who is president of the county officials' division and who is outstanding, nationally, for his knowledge of county highway affairs.

The Road Builders' work for better county road systems has the enthusiastic co-operation of the Rural Letter Carriers' Association and of the organizations of county highway officials in the various states.

Engineer Grubb brings to his new position a wealth of experience gained in 14 years with New Castle county, where he has dealt with every phase of urban and rural road and bridge construction and maintenance, involving an annual expenditure of $1,000,000.

He is a past president of the county highway officials' division which he now will manage; holds a B. S. and an honorary C. E. from the University of Delaware; member of the American Society of Civil Engineers and of various highway associations and committees; secretary of the regional planning commission of Delaware; a director of the Delaware Automobile Association and of the Delaware Safety Council.

## The 6th International Road Congress

Up to July 1 official delegates have been named by 40 nations to attend at Washington, D. C., Oct. 6-11, the sessions of the 6th International Road Congress and the exposition of road machinery and materials to be held by the American Road Builders' Association, according to congress officials.

The congress sessions will have papers on the leading highway problems prepared by some of the best American authorities and probably will be participated in by President Hoover, members of his cabinet and many other dignitaries of national and international importance.

According to reservations for exhibits received up to July 1 the exposition will give a representative picture of the road building industry in the United States, according to Charles M. Upham, engineer-director of the Road Builders' organization, who is in charge of the exposition. Both in the Washington Auditorium and the outdoor demonstrations, delegates will see the best equipment that America produces for road building.

During the entire week of the congress the exposition will be open daily, and the demonstrations of almost every type of road machinery will continue under simulated working conditions.

Following the formal opening of the exposition on Oct. 7 a luncheon will be tendered by the American Road Builders' Association to all present, with the foreign delegations as honor guests.

Among the far-off nations which already have announced official participation in the International Road Congress and Exposition are Algeria, Nigeria, Morocco, Indo-China, Syria and Lebanon. It is expected that all the impotant nations of the world will be represented at this first world road congress held in the United States.

Our federal government representatives in every foreign station are assisting in distributing news of the congress and stimulating in world-wide attendance among highway engineers and government officials.

# Concrete Pavement Maintenance

## Practice of Iowa State Highway Commission

By T. R. PERRY

Assistant Maintenance Engineer, Iowa State Highway Commission

DETAILED maintenance on concrete pavements naturally divides itself into seasonal operations; namely: fall, winter, spring and summer. Let us consider the fall of the year first chiefly because it is during this time of year when most of the newly constructed pavement is turned over for maintenance.

**Work in the Fall.**—The first duty is to seed the shoulders and right-of-way. In Iowa, rye is used for the first crop. Use plenty of seed and be sure it is thoroughly harrowed in. Four to six bushels per mile are required. The rye should be sown between Sept. 1st and Oct. 15 th. For final sodding we depend on volunteer seeding. Very good results have been secured by this method.

Other duties are to thoroughly clean up the right-of-way. Cut all brush and weeds that will cause snow to drift. Check all drainage structures to see that they are functioning properly. Erect snow fence wherever drifting can be expected. It may be of passing interest to know that Iowa used approximately 5,000,000 ft. of snow fence on 6,800 miles during the winter of 1929-1930.

**Operations in Winter.**—Winter activities are confined primarily to filling cracks and removing snow. Universally, crack filling has been carried on in a more or less haphazard way. The cracks were filled in many different ways. The extremes range from a crack filled to within ¼ in. of the surface to one which is completely filled so the material extends on either side 2 to 4 in. Frankly speaking, in the past no one knew why the cracks were filled, unless it was to admit something had to be done and we did it. Cracks have developed on the older pavements in every conceivable manner. On the newer designed pavements the number and character of the cracks have been governed to some extent. This has been accomplished by centerline joints, thickened edges, regularly spaced transverse expansion joints, treatment of subgrade, and the selection of materials. The best talent available is still deeply concerned relative to this phase of construction.

**Filling Cracks.**—The ideal time to fill cracks is when they are opened the widest. Unfortunately this condition occurs when it is the hardest to handle hot materials. Some of the cracks are 1 in. in width, while others are too small to take any material. Our studies along this line indicate:

First—It is necessary to fill the cracks in order to preserve the pavement.

Second—The cracks should be thoroughly cleaned before filling.

Third—The filling should be done in cold weather; that is, during early winter before the snow and ice come.

Fourth—Fill the crack to within ¼ in. of the top of the slab.

Fifth—Use as little material as possible.

Sixth—The crack cannot be made waterproof. This statement perhaps should be explained. Suppose a crack ½ in. in width is filled, later contraction of the pavement increases the width to ¾ in. The bond between the concrete and filler is broken. Ice ½ in. to 3 in. thick in extreme cases may form between the slab and subgrade. During the spring thaw the ice melts and the water is forced through the crack. The writer has observed this condition as late as June.

Seventh—Use a soft asphalt material with a penetration of 100-120 at 77°F. or a soft tar material with softening point not greater than 140°F.

**Snow Removal.**—Touching lightly on snow removal, we believe that all snow should be removed from the pavement and the shoulders of the road. During times of ice, sand or cinders treated with calcium chloride should be spread lightly on the surface of the pavement at sharp turns and on steep grades. The sand or cinders reduce skidding while the calcium chloride softens the ice on the pavement and, also, prevents the stock piles from freezing. Do not use salt to melt the ice because it will scale the surface of the pavement. Examine the surface of concrete walks or platforms at most any ice cream factory and you will see this effect.

Spring maintenance consists largely in keeping drainage structures open; such as, flumes, tile intakes and small culverts; and filling ruts along the edge of the pavement. Crushed rock is the most desirable for this work. The material can be handled very rapidly and easily by attaching a chute to the rear end of the dump body on the truck and spreading as the truck advances.

Summer maintenance consists of the following activities: mowing the right-of-way, marking centerline, repairing blow-ups, correcting settlements and making general repairs wherever necessary. Permit me to go into some detail concerning centerline marking, blow-up repairs and settlements.

**Centerline Marking.**—Iowa marks a centerline on all concrete pavement once each year. Two White army reconnaissance trucks have been converted into marking machines. Each machine has a solid rubber tired truck wheel mounted on the left side of the truck. This wheel makes a 5½ in. line. The paint barrels are supported on a frame above the level of the marking wheel. The paint flows by gravity to the wheel. Two men operate the machine; one drives the truck while the other controls the painting. Under favorable conditions this outfit will mark from 20 to 40 miles per day. A quick drying, black tar paint is used. This material costs approximately 22 ct. per gallon f.o.b. destination. The total cost of the marking is approximately $6.00 per mile for each marking.

**Repair of Blow-Ups.**—Blow-ups usually do not occur until after a pavement has been in place four or five years. Seldom will you find blow-ups on new pavement. Temporary repairs are made as soon as possible after the blow-up occurs. At some later time a regular organized crew completes the final repair. The Iowa instructions relative to pavement repairs are as follows:

"In the permanent repair of blow-ups the work will be organized on a 24 hour cycle. From morning until about noon the crew will clean out blow-ups and get them ready for concreting. The blow-ups will be cleaned out only half way across the pavement and the other half of the pavement kept open for traffic, all equipment being kept on the closed half of the road. The old loose concrete will first be removed, then the hole will be squared up with a pavement breaker so that the edges are vertical and at right angles to the center of the pavement. A form will be set to grade along the edge of the pavement and from 1 to 2 in. expansion placed transversally in the center of the patch. This expansion will be made of bituminous impregnated felt, a stock of which will be carried at Ames. Dowel bars will be placed through this expansion in the same manner that dowels are now placed on construction work. The subgrade will be cut out to a depth of 8 in. below grade, even though the old pavement section is less. The outside edge of the patch will be made 10 in. in depth. Marginal reinforcing of ½ in. bars will be placed in both divisions of the patch. After a patch has been prepared for concreting it should be carefully barricaded and protected with red flags and repair work signs 400 ft. each side.

"In the afternoon concreting will be started on the first patch which was cleaned out in the morning. Standard portland cement will be used but special precautions will be taken in the mixing. The proportions will be

carefully made by volume, 1:1½:2½, using the same class of materials as provided for construction work, except that the maximum size of aggregate should be 1 in. Calcium chloride in solution shall be added to the mix at the rate of 2 lb. of calcium chloride per sack of cement. The concrete will be mixed a full five minutes and as little water will be used as possible for proper finishing. The concrete will be carefully tamped in place and finished to grade. It will then be covered with burlap and kept wet the rest of the day.

"On the following morning the crew will open the first patch which was repaired on the previous day and will barricade the other side of the road and prepare that half as outlined above. In this way it will not be necessary to detour traffic and traffic will be confined to half width of the road only two days. We are justified in taking rather long chances in this time of opening as the damage is not great even if the entire patch is lost and the advantage to the traveling public in prompt opening of patches is immeasurable."

**Repairing Slab Settlement.**—Settlement of the slab on heavy fills has been very annoying to the maintenance department. This settlement is naturally due to a settlement of the subgrade. The following methods have been used in smoothing up the depression.

First—Fill sag with a tar or asphalt mixture.

Second—Fill settlement with crushed rock.

Third—Fill settlement with earth and surface with crushed rock or gravel.

Fourth—Fill depression with crushed rock and then seal the top with an oil, tar or asphalt treatment.

Fifth—Raise the slab back to its original elevation.

Sixth—Replace the slab entirely.

Our studies indicate that all of these methods have some drawbacks. The tar or asphalt filling works very nicely on settlements 6 in. or less in depth. Filling with earth, crushed rock or gravel is temporary. Replacing the slab is fine provided the subgrade has finished settling. Unless this can be definitely determined we recommend trying the other methods. Iowa expects to continue experiments along these lines during 1930.

**Raising Slab Settlements.**—In 1929 Iowa spent considerable time and money raising these settlements. The following method was used. A wooden truss consisting of two 3 in. by 12 in. by 16 in. bridge plank was placed over each transverse crack in the sag. Three 10-ton hydraulic jacks were placed under the edge of the slab directly below each end of the truss. A small hole was cut in the center of the pavement and an inch bolt with plate attached connected from the bottom of the paving slab to top of the truss. This bolt permitted the crown of the pavement to be retained when the slab was raised.

Each section to be raised was carried up in lifts proportional to the settlement at the point raised. For instance, suppose at one set of jacks the pavement was down 3 in. and at another set 12 in., probably the entire settlement would be raised in about eight lifts. Each lift would be ⅛ of the total depression at point of raising.

On settlements 6 in. or less the slab was raised 1 in. to 1½ in. above the original grade; on settlements above 6 in. the slab was raised to a maximum of 4 in. above the original grade, depending upon the depth of the settlement. The settlements raised varied from 3 in. to 26 in. in depth. Generally speaking, 3 in. depressions were the least that could be handled satisfactorily, due to the limited space available for proper filling. A cement gun was used to place the sand between the slab and subgrade after the slab had been raised to the required elevation. As much as 20 cu. yd. of sand was deposited per day in this manner.

It was interesting to note that the subgrades were often 3 in. and in some cases 7 in. below the bottom of the slab. In other words, the slab even though warped out of shape was self-supporting. With this condition existing the slab must necessarily continue to settle.

Approximately 4,900 sq. yd. of pavement was raised at approximately $1.75 per square yard. The corresponding cost of filling the settlement with a tar or asphalt mixture is estimated to be approximately $2.00 per square yard and replacing with new concrete at $3.00 per square yard. The cost of new concrete would naturally run high because the yardage involved is small and the jobs scattered.

The raising method has the advantage of leveling up the subgrade, whereas in making the surface treatments one can only hope there is nothing wrong underneath. We are not ready to advise our friends to raise their settlements but plan to continue our experiments during 1930. A careful check will be made of all settlements raised or repaired this spring after the frost goes out.

**Highway Beautification.**—This concludes what I have to say regarding detailed maintenance. Permit me to remind you that recently here in the middle west the maintenance engineer's attention has been called to highway beautification. Enthusiastic and elaborate ideas have been advanced but many of these cannot be carried out. If, however, this enthusiasm can be directed toward molding public opinion wherein advertising signs, telephone lines, power lines and hot dog stands are eliminated and thus cease to rob the beauty of our highways a real work will have been accomplished. May our energy be directed along this line rather than promiscuously planting a few rose bushes and flower seeds along the right-of-way.

In conclusion, let us all remember that our rear sight is better than our foresight. With this in mind, there should be the closest cooperation between the maintenance department and the construction department Construction programs are carried on with great speed. For instance, in Iowa we plan to construct 1,000 miles of concrete pavement. Weaknesses which the maintenance department has discovered even in last year's 750-mile program will be eliminated in the 1930 program. This cooperation is highly desirable from a maintenance standpoint unless the maintenance engineer loves trouble and plenty of the same kind.

Acknowledgment.—The foregoing is a paper presented at the 5th Annual Southwest Road Show and School.

## Van Duzer to Represent U. S.

William A. Van Duzer, of Harrisburg, Pa., president of the American Road Builders' Association, has been designated by the state department as a representative of the United States on the Permanent Commission of the International Association of Road Congresses, according to announcement from the Department of Agriculture.

The Permanent Commission, which is the governing body of the international association, has official representation from fifty-one member nations. Van Duzer will stand for the membership of the American Road Builders' Association, which includes officials and engineers in every section of this country and in every phase of the highway industry.

He is particularly conversant with highway affairs of the United States through many years' association with the Pennsylvania Department of Highways, of which he is assistant chief engineer. He has held membership and offices in many highway groups and has been particularly distinguished by studies of purchasing methods, standardization and depreciation of highway equipment.

The object of the Permanent International Association of Road Congresses, which has headquarters in Paris, is set forth as "to promote progress in the construction, traffic and exploitation of roads." This is accomplished by organization of world-wide road congresses, such as the 6th International Road Congress which comes to Washington Oct. 6-11, by publication of road construction information, and by tests of roads and materials carried on in various parts of the world.

As a feature of the coming congress, the American Road Builders' Association, which Van Duzer heads, will stage an exposition and demonstration of road building equipment in Washington, where the newest and best products of highway manufacturers will be displayed.

# Gas Fired Boiler for Asphalt Plant

## Municipal Plant of Pittsburgh With an Average Output of 150,000 Sq. Yd. of 3 In. Surface Has Gas Burners

By J. B. NEALEY
American Gas Association

IN the City of Pittsburgh, Pa., gas fuel is used under the boiler at the municipal asphalt plant No. 2 instead of coal, in spite of the fact that the latter is available at $2.70 per ton delivered. With gas at 45 cts. per 1,000 cu. ft. it has been found to be cheaper than coal. It eliminates four firemen and the necessary laborers for coal and ash handling while the storage space for coal and ashes is available for this purpose.

The Pittsburgh asphalt plant No. 2 furnishes, on an average, 150,000 sq. yd. of 3 in. asphalt surface in eight months. This is usually composed of 1½ in. of binder consisting of asphalt, sand and slag and 1½ in. of top composed of asphalt, sand and lime. The average cost is $1.66 per sq. yd. including overhead and depreciation of plant and equipment, etc.

**Material Handling.**—Cars of asphalt are spotted on a railroad siding close to a pump house and a steam line is attached to the steam coils in the car and steam admitted. It requires from 6 to 12 hours to soften up the asphalt. A steam jacketed flexible hose is then attached to a bottom outlet in the car and suction applied with a steam pump which draws the asphalt through the hose, through a strainer in the pump house and on up into the storage tanks. There are two steel storage tanks of 80 tons capacity each, and it requires only 60 minutes to unload a 40-ton car.

A steam crane with a grab bucket, operating on a parallel track, is used to unload sand, slag, lime, etc., which is

The Asphalt Tank

stored in piles on the opposite side. The lime dust however, comes in bags and this is taken by an elevator conveyor up into a storage bin holding 40 bags. In fact all of the ingredients are held in elevated storage bins and dropped by gravity directly into the mixers.

**The Dryers.**—The sand is first dried in a revolving steel drum enclosed by a brick furnace. The drum is 26 ft. long and 5 ft. in diameter and makes 6½ revolutions per minute. It sets at a slight angle so that the sand works through and discharges automatically. Heat is supplied by four atmospheric gas burners, and the temperature is maintained at 500°F. with the aid of a recording pyrometer. The capacity of this dryer is 40 tons hourly. The sand discharges into a chute which protrudes through the side of the furnace wall and directs the sand into a bucket elevator. This lifts it and drops it through a screen into a storage bin. Another dryer, identical to the one described, is used for drying the stone or slag.

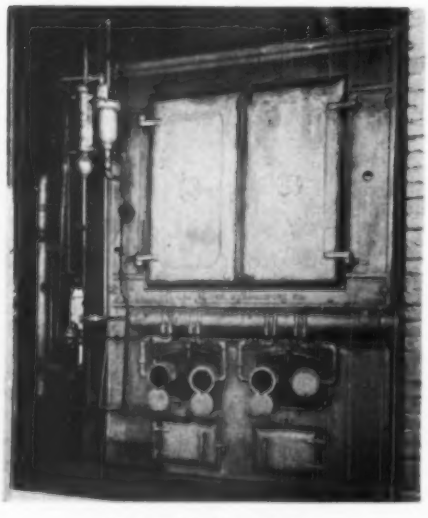
**The Batcher.**—Batches of 1,500 lb. each are made up by drawing the sand, slag and lime from storage into weighing hoppers and the asphalt into buckets holding the correct amount. These ingredients are then dropped into the mixers. The asphalt tanks are equipped with steam coils and when ready to use the steam is turned on and the asphalt melted, 330°F. being the flowing temperature. Compressed air from a steam operated compressor is admitted to the tanks through pipes and this forces the liquid asphalt out into the buckets.

The usual 1,500 lb. batch for the top coat will contain 150 lb. of asphalt, 270 lb. of lime dust and 1,080 lb. of sand. There are other mixtures but this is the one most commonly used. The sand is used out of storage as soon after coming from the dryer as possible so as to preserve the heat but the lime dust is dumped in cold. These are weighed out in the weighing hopper and then dumped into the mixer with the asphalt.

There are two mixers built of steel plate about 5 ft. square and 3 ft. deep. They are jacketed so that steam can be admitted to keep the mixture up to temperature, about 500°F. equipped with two sets of heavy steel paddles on shafts. A 30 hp. motor operates both. The batches are dropped into motor trucks, holding about 9,000 lb. each, at a temperature range of 350 to 370°F. and are distributed within an average radius of 12 miles. From 10 to 12 trucks are thus employed.

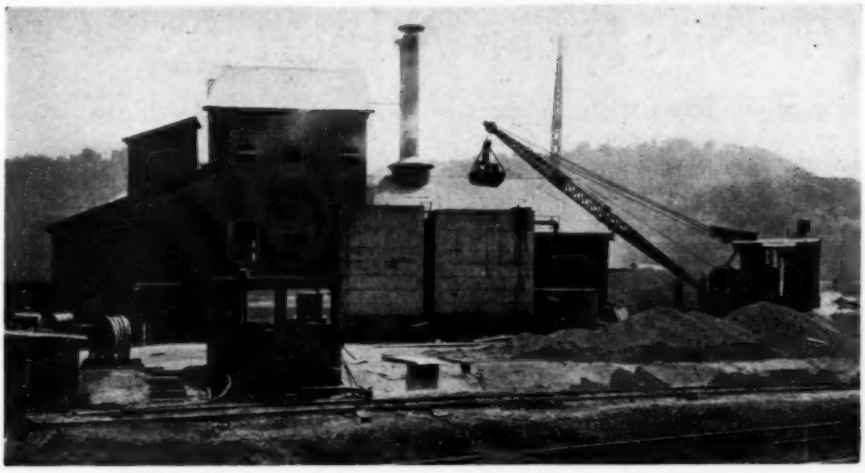
**The Steam Supply.**—The steam supply of this plant is furnished by a steam boiler of 150 hp. capacity, which is fired with gas burners. This installation is of the horizontal return tubular suspension boiler type fired with coal. However, for the sake of economy, gas burners were later provided and gas fuel has been used ever since.

The boiler is 72 in. in diameter and 16 ft. long and it is 52 in. from the floor level to the underside of the shell as shown in the side elevation. The burners are set in a firebrick wall which blocks the fire door opening. There are four of these burners and they are manifolded to a single header. All metal surfaces exposed to the heat are



Gas Fired Steam Boiler

Gas Fired Rotary Sand Dryer



General View of Asphalt Plant and Stock Yard; Pump House in Foreground

protected with a refractory material excepting only the water lined surfaces.

As air must be admitted and premixed with the gas in a predetermined ratio for perfect and complete combustion, the firebox is sealed airtight. The admission of air is provided for in the burners themselves through an adjustable shutter at one end of the burner mixing chamber. Gas is admitted to this mixing chamber through a series of small perforations, and the quantity is regulated by means of three regulating control valves. In addition to the economies effected through the use of gas fuel already mentioned, it is of interest to note that in the 15 years of service this boiler has undergone only once has it been necessary to change tubes.

## Street Sanitation at Milwaukee, Wis.

The following notes on street cleaning, ash and rubbish collections and snow removal at Milwaukee, Wis., are taken from the recently issued 1929 report of the Commerce Council on Municipal Government and Activities:

The bureau of street sanitation has a ward yard in each ward of the city from which the ward crews operate in the performance of the various tasks necessary to keep the streets clean, the highways open, and to dispose of emergencies which arise. These duties give employment to an average force of 190 teamsters, 676 laborers, and a considerable amount of motorized equipment.

In cleaning streets, use is made of team hire, labor, and motor service in various ways. Seven power sweepers are kept busy most of the year. The laborers and power sweepers deposit their collections at advantageous points where teamsters pick up the refuse, and it is carried to the dump. This pick-up may be made by an ash collecting crew if there is any saving in so doing.

Business streets are cleaned daily. In such areas there are whitewings who work continuously in keeping their sections cleaned. Gutters in residence sections are swept and cleaned at least once every two weeks. Alleys are cleaned of all free rubbish by the ash collection crews in the course of their work.

The quantity of sweepings carried to the dumps was 122,000 cu. yd. Expenditures for cleaning streets amounted to $346,644.63 during 1929.

Seven power flushers generally operate two 8-hour shifts daily in warm weather. Horse-drawn flushers are also used as conditions require them. There were 125 million gallons of water used for this purpose.

Sprinklers, operated to lay the dust where it causes distress, used approximately 28 million gallons of water in 1929.

It cost the city $770,301 to remove 707,867 cu. yd. of ashes and rubbish from households during 1929. This is an increase of about 45,000 cu. yd. and $72,159 over 1928. The growth of the city necessitated an increase in service, and the rate for team hire increased.

Practically 80 per cent of the rubbish is now hauled to the dumps in trailers. It is found that this method is more economical on account of the greater capacity of the trailer box. Ashes and rubbish removed from business places, the cost of which is charged directly to the firms, amounted to $27,250.

Under the removal of snow are included the removing of snow and ice from highways, the opening of crosswalks and catch-basins, and the sanding of dangerous intersections. As the amount of snow is variable, the amount of money expended for this purpose will fluctuate greatly from year to year. During 1929, $338,947 was used for snow removal, as compared with $59,422 for 1928. The unusually heavy snowfall during the past year made it necessary to employ 614 extra men and 79 extra teams in January alone.

## States will Complete Numbering of U. S. Highway Routes in 1930

Reports received by the Bureau of Public Roads, U. S. Department of Agriculture, indicate that the work of erecting the standard markers for numbered routes in the United States System of Highways will be practically complete at the end of the construction period of 1930. The system was adopted less than five years ago by State Highway Departments, and comprises approximately 97,000 miles of the most important highways of the nation. Practically all of these routes are also in the Federal-aid highway system.

Ten main east and west routes, designated by multiples of ten, and eleven important north and south routes, numbered 1, 11, 21, 31, etc., up to and including 101, form the backbone of the system. The system includes not only these important through-routes but also many crossovers that connect main routes. The highways of the system reach practically all of the large cities and serve every section of the country. The crossover or branch lines are indicated by three digits, such as 290, 141, etc.

All east and west highways, as well as their branches, have even numbers; all those running north and south, with their branch lines, have odd numbers.

The signs bearing the numbers are of standard size, and are in the shape of a shield. They have a white background on which appear, in black, the name of the state, the initials "U S" and the route number. Generally, the markers are erected one mile apart.

Work on the designation of a system of United States highways started in February, 1925, when, on the recommendation of the American Association of State Highway Officials, the Secretary of Agriculture appointed the Joint Board on Interstate Highways, consisting of State and Federal officials, to undertake the designation.

Suggested systems, submitted by the states, were harmonized by the board and final selection and report was made in November, 1926. The report was approved by the Secretary of Agriculture. The United States System of Highways was then mapped accordingly. The original system included 80,000 miles of highways. From time to time additional mileage has been added until today there are approximately 97,000 miles of the most important highways of the country in the United States System of Highways.

**State Regulation of Taxicabs.**—Rhode Island has placed the taxicab under state regulation. The state utility commission has been given powers to fix rates, specify service and stipulate equipment needed. Connecticut also has state regulation.

# Selecting the Site for an Airport

## Factors Considered in the Selection of the Site for the Airport of Wayne County, Michigan

THE highway engineer with his knowledge of grading, drainage, surfacing, snow removal and pavement maintenance is particularly fitted for the construction and care of airports and their runways. In fact the airport of Wayne County, Michigan, is being developed by the county road commission under the immediate supervision of the engineer-manager. The development and operation of the Detroit City Airport was assigned to the chief paving engineer of the city engineer's office. At the recent 16th Purdue Road School Mr. Perry A. Fellows, city engineer of Detroit, Mich., presented a comprehensive paper on the Detroit City Airport. That portion relating to the selection of site is abstracted below.

**Purposes to Be Considered.**—Selection of the airport site should be preceded by a study which will take into consideration the purposes which the airport will serve, the various factors of value in satisfying such needs, and the elements of cost.

The proposed expenditure will be expected to satisfy various related needs. These needs should be carefully studied and their relative importance weighed. The characteristics of standard sites as set up in the requirements of the United States Department of Commerce should then be examined with these requirements in mind in order to determine their fitness to serve the needs thus established. Student training, sales demonstration, club service, experimental work, exhibitions, circuses, national guard training, mail, express, sightseeing and taxi service are not satisfied equally by the same features of a single field. It may be possible that more than one field is to be made available. If so, a smaller field close in may answer all the essential requirements for a downtown terminal catering to mail, express and some scheduled passenger flights. Another location, more remote, may then very well be selected for the services that require larger areas. The only difference in such a case is that we no longer have a single selection to make, but more than one and these selections will be based on different requirements.

**The Ideal Field.**—The ideal field should be close to the downtown centers, close to the center of population and should be located for maximum convenience of the approaching pilot. It should have at hand the best means of surface transportation. The character of the neighborhood should be suitable. It should be free from fog and smoke. Its surface and area should be such as to permit the maximum use in all seasons and under all conditions of weather. Probably no field which will be considered will have a perfect score. That will be for the ideal alone and the ideal will usually be unattainable. But the total points scored by any field or the total units of suitability will be a valuable guide for further study.

If it were necessary only to secure the greatest possible area for a predetermined sum of money the selection would be a simple affair. There are other factors. Some of these are obvious. Some are apparent only after study. The greater the number of these factors, the more difficult becomes their relative valuation and the more apparent becomes the necessity for comparison on an engineering basis.

**How Wayne County Handled the Problem.**—A practical application of this method has been tried at Detroit. The people of Wayne County, Michigan, voted at the election Nov. 8, 1927, an approval of a bond of $2,000,000 for the purpose of securing a site or sites for municipal purposes. To the ways and means committee of the board of supervisors was delegated the task of making recommendations. This group in turn was advised by a special airport committee of five men. After several months of study and examination of sites this airport committee employed the services of an airport designer to make a survey and suggestions. It is said that 122 proposed sites were examined. Of these, 15 appeared in the report submitted. General information about the 15 sites was included in the report and sites numbered 1, 2 and 3 indicated as first, second and third choice, respectively. The number of other sites did not bear any relationship to their desirability as airport locations. A suggestion as to the development of the three sites was also offered.

The airport committee after an examination of the report failed to agree, the majority report being in favor of site No. 8 and the minority in favor of No. 2. The ways and means committee in turn considered all the sites reported and some which were submitted subsequent to the filing of the preliminary survey. They narrowed the field down to six possible sites for final consideration.

**The Scoring System.**—At this point the engineer-manager of the Wayne County Road Commission and the city engineer of Detroit were asked to cooperate in setting up a scoring system on the basis outlined herein. The request did not call for a choice, but for a means of assisting the committee in making that choice.

Since the final scoring was apparently to be in non-technical hands, it was considered advisable to simplify the process as far as possible. A chart was prepared in which the items of operation value and the items of location were set up under the single heading "Factors," subdivided into nine items scoring a possible total of 1,000 points. The total cost set up included all the cost necessary to bring the sites to a uniformly comparable basis. From these two totals the index cost could be obtained by dividing the total cost by the total points scored.

It was also pointed out that "Each of the areas with the construction contemplated will comply with the essential requirements of an "A-1-A" airport. The additional factors which have been set up attempt to evaluate the other desirable features. These values have been placed only after careful consideration of their relative importance. They are applicable to the Wayne County area only and would be varied for any other location where basic conditions are different.

The rating takes into consideration the probable use for student training, plane manufacturers' testing and sales demonstrations, etc., as well as use by private individuals and use for public demonstrations. The distribution shown by the report is as follows:

"1. Center of Population—170.

"Under this general heading have been grouped manufacturing centers, retail trade centers, accessibility of airport to individual citizens, proximity to aviation clubs, also comparative use of reaching any portion of the city by taxi-cab. Time to reach the port at reasonable automobile speeds is a factor in the distribution between sites.

"2. Downtown Centers—290.

"In setting up values for this factor, we have taken into consideration the location of the postoffice, express offices, financial district, depots, hotels, as well as water terminals, and the means of reaching these various centers. In fixing this value, and the preceding one, credit has been given to the fact that there is an available port at French and Lynch Roads, otherwise the rate should have been placed even higher. Time is also a factor.

"3. Airways—180.

"Transcontinental lines. Weighted for per cent of traffic inbound from each direction, and probable future growth of traffic on lighted airways."

In case of special case of identifying airport from air, allowance should be made, but it should be kept in mind that the airport will be provided with standard markers, beacons, etc.

"4. Transportation Facilities—120.

"Under this heading the location of existing bus lines, paved roads and trolley lines has been weighed, but it is recognized that these facilities can

be easily supplied if lacking and are, therefore, not a determining factor in the selection of airports.

"A greater value has been given to the proximity of railroads, based on the development of airplane factories and accessory manufacturing plants, also as a means of exchange of mail and express and possible development of commuter service, keeping in mind the fact that the railroad is not much faster than the automobile within the city limits and that air-travel business of itself will probably not justify train service at schedules to accommodate air business alone. It will require the building up of heavy suburban population to warrant frequent service. It must also be borne in mind that railroad service is not as flexible as bus service or the individual motor car.

"5. Character of Neighborhood—40.

"Restrictions. In the consideration of this factor the building restrictions or possible zoning regulations which might place a limitation on the character of the buildings in the neighborhood should be taken into consideration so that the future outlook as to the development of sites for airplane factories and allied industries, as well as homes for workers at these industries may be taken into account; also the probability of construction of high buildings or other undesirable areas under take-off.

"It should be borne in mind that the sites now under consideration are all located in neighborhoods where most features of this character will be of importance only in the distant future, which makes it unnecessary to put a high rating on this item.

"6. Fog—40.

"Fog and mist are not rated with smoke because we feel that the distribution of effect is not the same.

"Records of 20 years at the local weather bureau are confined to downtown areas and may not be applied to other points without recognizing the fact that conditions vary. Fogs though generally found in low and moist spots, may occur in widely scattered locations and sometimes at higher elevations. Such instances are more like very low-hanging clouds or low ceiling.

"7. Smoke—40.

"The character of smoke distribution is determined by the location of the manufacturing districts, the season of the year and by the directions of the prevailing winds.

"The prevailing wind in this region is from the southwest and therefore the south and west sides would be least often interferred with by the presence of smoke.

"Rating value takes into consideration the fact that the airport will probably be far enough from downtown and manufacturing districts to reduce the importance as far as smoke is concerned.

"8. Area—100.

"If no maximum or minimum were to be placed on the size of the site selected, this factor would be of great importance. A minimum restriction of area large enough to provide a No. 1 rating is presumed. A maximum area of one mile square is also presumed and no credit for airport purposes allowed beyond that size. It is believed that if any areas larger than one square mile are being contemplated, then, for purposes of comparison, the price for one square mile should be used.

"9. Soil and Ground Conditions—20.

"Value for this item is set low because of the fact that artificial drainage will be needed for any selected.

"The ease of drainage will be reflected in the cost of sewers. This factor will be higher for clay than for sandy soil. The low land will presumably be the most difficult to drain, especially if the tests indicate wet clay under a considerable portion of the area.

"In this factor allowance should also be made for the effect of rain on top soil and possibility of securing quick growth of tough sod. It is presumed that a reasonable amount of hard surface runways will be provided for any field which may be selected.

"10. Other Items (Not rated).

"Telephone, telegraph, light and power are not set up for comparison because they are easily available in nearly every part of the country.

"Water is available at most sites and if not available can be secured and the cost included as a part of the total cost of the airport.

"In setting up the values, future development of aviation has been considered. We have also assumed the probable development of the Municipal Port at French Road and Gratiot.

"No value has been set up for possible official connection with transcontinental railroad traffic. This is something which can be given such weight as the character of the evidence submitted seems to warrant.

"The committee may also wish to consider the time it will take to acquire the property. The fact that some tracts are completely under one control is given no weight here.

"Costs.

"To the initial price of the land should be added the estimated cost of clearing and grubbing, grading and draining, and of any other items essential to make the fields comparable. This total cost thus obtained for any particular site, divided by the points scored for that site, will give an index of cost which may aid in selecting one from a number of sites of almost equal desirability."

Supplementing the report thus submitted and in response to an informal request, this scheme was carried further by actually filling in tentative values for the six sites only by preparing charts which showed graphically the basis upon which these scores were made. These figures as set up gave site No. 1 the highest score, if money were not considered, and sites No. 2 and No. 8 the next highest score. When the costs were considered, it was found that the lowest cost per point scored was for site No. 16 with No. 2 second. With this information, the votes of the ways and means committee were about equally divided between site No. 2 and site No. 16. The final selection of site No. 16 by the board of supervisors was made Sept. 28. To what extent the supervisors were guided in their final selection by the analysis shown is uncertain, but the fact remains that the choice was not made without the benefit of systematic comparison at least.

## Argentina's Second Concrete Paved Road

Although considerable cement concrete paving has been done in Argentina, according to Assistant Trade Commissioner Thomas C. Ballagh, in a report published by the Automotive Division, Department of Commerce, only one highway surfaced with that material has been built—the first section, 3.7 miles long, of the proposed road from Moron to Lujan in the Province of Buenos Aires. That section was completed in 1929, and construction of the remaining 26 miles is now under way.

By coincidence, the second concrete road being built also runs to a town named Lujan, but in the Province of Mendoza. A stretch of 7½ miles will connect Lujan with Godoy Cruz, a suburb of Mendoza City, and a branch will run from Godoy Cruz to Maipu, 8 miles. Over the existing roads to both these towns there is at present a very heavy traffic, particularly in the grape harvesting season. Long lines of two-wheel carts bring the grapes into the wine making establishments of Godoy Cruz, where they are pressed into the wine upon which the prosperity of Mendoza is almost entirely dependent. The new concrete road will help in the substitution of automobile trucks for the carts, and will increase the present omnibus traffic between the towns.

In building the road the Provincial Government of Mendoza has followed specifications of the State of Illinois. Longitudinal joints are used, but no transverse joints. The width of the concrete is 19.7 ft. The cost has been fixed at approximately $765,000. Completion during 1930 is expected.

**Tree Census at Syracuse, N. Y.**—The city of Syracuse, N. Y., is believed to be the first municipality to undertake a comprehensive tree census. The trees recorded totalled 53,386, with American elm, sugar maple, silver maple, and Norway maple predominating. The census was taken by State College of Forestry students.

# Frost Action in Shoulders and Subgrades

## The Causes and Methods of Control of Damaging Frost Boils on the Highways of the State of Wisconsin

By W. C. BUETOW

Chief Engineer, Wisconsin State Highway Department

FROST boils occur yearly, but not necessarily in the same spot each year. The same areas in the state have the yearly trouble, but the particular highway may not be impassable in the location that it was the year before. You will say that that is easy to explain. Some corrective agencies were applied the year previous, but what about those spots that just naturally heal themselves? That's a different case for the doctor and a purely speculative one. Unfortunately, the same doctor has not been retained for a study of the troubles over a period of years. Before the problem can be solved successfully a serious study of soils will have to be made as to their composition and their capillary powers. This, with various drainage problems, will, no doubt, lead us to a solution.

The first step in the diagnosis is to find the location of the trouble. The eruptions, strange as it may seem, usually occur in cuts or near the point where the cut ends and the fill begins. In hilly country the side hill roads are bothered considerably in addition to the lower level roads. While we know from past experience where the boils usually form, yet it is impossible to point to a spot during the summer months and say, "Here is a spot that will go to pieces next spring." Why the eruptions do not come regularly each spring, even though no treatment is given, is difficult to say, except that nature performs wonders.

**Kind of Boils.**—There are two kinds of boils, at least, in Wisconsin. The first appears, note I am not positive in this statement, to be caused by a live vein of water just under the subgrade and usually appears on side hills. Troubles of this kind have in many instances been traced to a lake or swamp area which may be close at hand or miles away. The second type of boil, the kind that makes the most serious trouble, generally appears on more level stretches of road, and where the roadbed is built of a fine medium clay superimposed on a non-porous subsoil of exceptionally heavy clay or hardpan. These two types just described are the Wisconsin brand of boils. There may be others, but we are not familiar with them.

**Time of Formation.**—Frost boils, from their name, start forming with the first good freezing weather. If there happens to be a good fall of snow before the cold weather sets in, conditions heretofore mentioned would not be so bad in the spring. Snow acts as a blanket and prevents the frost from penetrating to a considerable depth. However, in this age, when there is a demand to have the roads open during the winter, frost has an opportunity to reach quite a depth. Snow removal is a detriment in this respect. If there were no ground water present, neither the freezing weather nor snow removal would cause bad conditions in the spring.

**Time of Breaking Out.**—The time of the year when the boils start acting is usually in the early spring, when the days are warm and the nights bring light frost. Naturally, the southern part of our state experiences the trouble the first part of early spring, and the northern part of the state, several hundred miles further north, is not disturbed some years until as late as June. The time of the year is directly dependent upon the depth of the frost.

**How a Boil Acts Before Breaking Out.**—Usually the snow has almost disappeared before the usual signs show on the surface of the semi-rigid type of pavement. With the concrete surface the usual symptoms cannot be detected as readily, except when water oozes through the joints or cracks and leaves a finely divided sediment on the pavement. In the unsurfaced and semi-rigid types of road, the entire surface quakes as a concentrated load is applied. Before the frost has gone out enough to start the boil to act, the frost is drawn out of the upper 6 in. to a foot of the surface. This much of the surface dries out readily and becomes a hard crust in an unsurfaced or gravel road. A thickness of 6 in. will sustain quite a load. The surface, from all outward appearances, seems to be in good condition. As the frost goes out below this, there are changing conditions underneath, which soon show on the surface. There are times during the breakup when a person is able to cause quite an area to quake by the shifting of his weight. If travel were kept off the highway during this time, the surface would remain intact. The passage of vehicles over these spots causes a puddling action and stirs up the mess underneath the crust. When the subsoil is worked into a semi-fluid state the surface becomes warped and cracked in places. As soon as this happens an eruption starts with the ejection of the mud by boiling action. Travel, continuing over these areas, breaks through and becomes mired. What a mess then results, due to the relief vehicles pulling the distressed ones out. Everyone becomes disgusted with the highways and the highway organization. Each year there is a lot of free advice given the department by the laymen about getting away from the nuisance. For instance, we have been told to fix these boils during the summer and fall months, thereby eliminating the trouble in the spring. That is a fine idea, but it would take a superwizard to locate the spot that will be troublesome. In one of our northern counties the road became impassable yearly, not in its entire length, but in spots. As soon as one of these spots was taken care of the infection broke in a different place the following spring. Before this particular stretch was cured the frost boil was chased half way across the county. This illustrates, in a measure, the nature of the ailment.

**The Causes.**—The chief cause of frost boils is ground water and the lack of adequate drainage in the soil itself. Water gets into the ground by soaking in from the top or by capillary action. No matter how it gets there it is a damaging element in a roadbed. We all know that when water freezes it has tremendous expansion powers. The same condition exists when it is mixed with earth, and it would seem that the earth would be loosened up and when thawing takes place the water would escape. This probably would be true if the frost would leave uniformly throughout the roadbed. Many other factors change this condition, namely the snowbanks in the ditches, the vegetation on the shoulders and slopes, and the early thawing, with the incidental early drying out. This last mentioned condition acts as an insulator and prevents rapid thawing downward and toward the center of the road. Thawing, however, is gradually taking place below the traveled part of the road. The freed moisture is surrounded on the sides and bottom by remaining frozen earth, and cannot escape either to the ditches or to the subsoil. As moving loads pass on the dried out crust we have the agitation mentioned before, resulting in a frost boil breaking out through a rupture in the crust. This describes briefly the causes for a boil forming.

**Temporary Curing.**—When a frost boil has formed emergency measures must be resorted to, to provide the travel a means of passing over and

through those spots with as little inconvenience as possible. Draining the center of the boil, of course, is best. There are several other schemes, such as trenching to the side ditches, by dynamiting down through the frost to the unfrozen subsoil, or by steam jets thawing out the frozen ground. When equipment is not available for those measures, then the moisture should be absorbed by the use of sand, fine gravel or stone. Troughs made of wood or metal are sometimes placed on the surface for the vehicles to travel on during the breakup. This, however, is used only where materials are not available or the boil is too long. One-quarter mile stretches have not been uncommon some years, but such conditions are gradually being eliminated. The use of proper materials to dry up a boil and to form a crust over the crater is very much appreciated by the traveler. In years gone by anything close at hand was thrown on the affected spot, like hay, sod, cornstalks, and even railroad ties were used. Those materials are really a detriment because all, excepting the ties, while they permit vehicles to pass over rather than through the road, retain moisture long after the entire frost has left the ground. Large rocks or field stones dumped into a boil will help for a year or so, but as soon as the voids become plugged with the soil they do not function any longer, and we are back at the place where we started. In addition these stones soon find their way to the surface during the ensuing periods of the year.

**Methods Used in the Eradication.**—No doubt a great deal could be done in the eradication by means of studying soils and the distribution of them in the earthwork. Such a procedure would, without a doubt, require a greater outlay of money in the grading work, but would result in less cost over a period of years. The expense of taking care of frost boils during the spring breakup is no small item. Later in the season the surface must be restored at an additional expense. If we add to these items the inconvenience of the traveler, a goodly sum will be the result.

The best means of the water elimination is through efficient subsurface drains. In those soil types that are susceptible to drainage trenches, longitudinally and transversely filled with crushed rock, clay tile, perforated metal pipe and artificial strata have been used successfully. The artificial strata have proven to be the most efficient, but are much more expensive. The process involves the excavation of about 20 in. and laying on the floor of the excavation about 8 in. of sand and gravel. This layer should extend the full width from shoulder slope to shoulder slope. The grade is then restored by filling selected earth on this layer. Heavy plastic clays and other especially retentive soils should not be used. A porous layer of sand and gravel will not entirely shut off, but will retard to some extent capillary action and will collect such surface water as will find its way through the upper strata. Water finding its way to the porous strata can readily flow to side ditches and be carried away. Frost will penetrate to a greater depth than 20 in., or the bottom of the porous strata, thus tending to form boils. Even if boils do form below the 20-in. depth, a crust of this thickness will sustain a considerable load without breaking up. Should the boil begin to ooze, the moisture would be expelled into the porous strata and pass on through to the side ditches of the road.

The stone, tile and metal drains are used quite extensively. In the denser plactics and retentive clays drains cannot draw water laterally very much. It takes many lines to do much good. Such soils are subject to considerable heaving, and tile lines are readily displayed. The perforated metal pipes do much better in these soils on account of the fewer joints. Those methods of subsurface drainage do not function forever. Porous material covering the tile and perforated pipe becomes clogged and the voids in the stone drains become silted up, then the pipes and trenches cease to function and we are again subject to the disturbance of boil action.

In the extreme northern part of the state we have a very heavy plastic red clay soil that does not give us trouble. About 15 or 20 miles inland from Lake Superior the soil changes to a less plastic clay, and here is where the frost boil trouble begins, and only ends when we encounter the sandy section of the state. This shows that the type of soil has considerable to do with the trouble, and until adequate research work has been done we will not be able to rid ourselves of this great plague, the frost boil.

Acknowledgment.—The foregoing is a paper presented at the 8th annual Asphalt Paving Conference.

## Laboratory Tests for Concrete Culverts

In testing concrete culverts, the testing department of the North Dakota State Highway Department actually breaks sections of culverts to see how much pressure they will stand. This is done by means of a hydraulic jack with a pressure gauge. This method enables the load a section of concrete culvert can stand to be determined.

An absorption test is also made on concrete culverts. This is done by taking specimens from 12 to 20 sq. in. in area, free from visible cracks and fissures or shattered edges, and drying them until they have reached a constant weight. After the final weighing and drying, the specimens are cooled, placed in boiling water for 5 hours and then cooled in water to a temperature of from 10 to 15 deg. C. Water on the surface is wiped off and the specimens are weighed. The water absorbed is then calculated as a percentage of the initial dry weight. This test establishes the density of the concrete. Concrete that is porous and holds water is more readily broken down by frost action or by allowing freer contact with certain chemicals that are carried by water.

## Combating Frost Boils with Dynamite

Dynamite has been used on frost-boil areas by A. C. White, county engineer, Mower County, Mo., for the past three years with marked success, according to "Explosives Progress." He has found, it is stated, that the work can be accomplished in a much shorter time than by the use of hand labor.

The procedure followed in getting rid of a soft area of rather unusual extent was to use two sticks of dynamite per hole in a row of holes on 2-ft. centers. Twenty holes were shot at one time. Electric blasting caps were used for priming, and the charges were detonated by means of an electric blasting machine.

Some success has been recorded in the prevention of frost boils by providing underdrains at the troublesome areas. One way of accomplishing this is to blast strips of land at points on the side of the road where the boils occur and fill the trenches with field stones or rocks. In this way, water is carried off instead of being allowed to accumulate.

**France Standardizes Highway Signs.**—A series of thirteen important road signs, standardized as to form, size, and color, have been approved by the French Ministries of Interior and Public Works, and the perfectures of all departments have been advised that highway markings must conform to the standardized specifications. The new standardized markings cover signs showing directions and distances; turns, railroad crossings, entrance into towns, etc. The sizes of the lettering, colors, dimensions of the signs, donors' name, height from ground, and other details are specified. The "Commission de Signalisation," which studied the problem and made recommendations to the government, was composed of representatives of touring clubs, automobile associations, the National Tourist Office, and Chambre Syndicale des Constructeurs d'Automobiles. In arriving at their conclusions, account was taken of the dimensions of a large number of signs already in use which were donated by a tire company and which have already been standardized, thus obviating the necessity for the expenditure of a large sum of money for the erection of new signs.

# State Highway Department Car Operation

## Data on Cost of Operating Automobiles for a 4-Year Period by the North Dakota State Highway Department

THE State highway department of North Dakota operates its own automobiles for the transportation of certain employees in the performance of their duties in supervising the construction and maintenance of highways, gravel prospecting and gravel checking. These cars are of the small light type and are commonly classed as light fours and light sixes. An accurate record has been kept for the past five years of the operation of this fleet, and the June "Highway Bulletin" of the department gives the following interesting facts and figures on these cars:

We propose to show in this article car operating costs of this department, distributed to the different items of expense, such as gas, oil, tires and tubes maintenance, depreciation, license, interest at 6 per cent, insurance, garage and miscellaneous expense. The period covered by these figures is from Nov. 1st, 1925, to Dec. 31st, 1929.

In connection with the costs of operation as distributed, will be shown for the purpose of comparison, figures as compiled by the Iowa State College experiment station in their Bulletin No. 91 covering the cost of operation of over 800 cars as reported by fleet owners statistics.

As shown in the accompanying table the highway department cars average a total cost of $0.0608, while the average cost per mile as compiled by the Iowa State College shows $0.0602 per mile. Both figures are based on the same class of cars, namely, light fours and light sixes of different types such as touring, roadsters, coupes and sedans.

Nearly all items of expense that enter into the operation of a car have been declining in price year by year, even the original price of the car itself which is concerned in the cost of depreciation.

**Cost of Automobile Operation**

| Cost | | *N. D. Cost Per Mile | †Iowa Cost Per Mile |
|---|---|---|---|
| Gas | $ 40,314.24 | $0.0143 | $0.0134 |
| Oil | 7,613.25 | .0025 | .0025 |
| Tires | 11,719.74 | .0041 | .0060 |
| Total Operating | $59,647.23 | $0.0212 | $0.0219 |
| **Upkeep** | | | |
| Maint., Labor, Parts, Misc. | $48,962 79 | $0.0172 | $0.0155 |
| Storage | 8,750.32 | .0033 | .0044 |
| Total Upkeep | $57,713.11 | $0.0205 | $0.0199 |
| **Overhead** | | | |
| Admin., Chief Mech. & Accnt. | $17,550.00 | $0.0062 | |
| Interest } License } Ins. & Misc. } | 5,140.33 | .0080 | Int. .0027 Lic. .0011 Ins. .0021 |
| Dep. | 31,147.05 | .0111 | .0125 |
| Total Overhead | $53,837.38 | $0.0191 | $0.0184 |
| Total Cost | $171,197.72 | $0.0608 | $0.0602 |

*N. D. highway cars, period 11-1-25 to 12-31-29; 50 per cent lowtype roads, 50 per cent intermediate type roads (estimated).

†Iowa State Bulletin costs per mile based on average 11,000 miles per year per car used on intermediate type road.

**Relation of Different Type of Roads to Fuel Consumption.**—Roads may be classified as high type or paved; intermediate type such as gravel; and low type, or earth. On an average throughout the year, if a vehicle will travel 15 miles on a high type road per gallon of gasoline, it will take 1.2 gallons to travel 15 miles on an intermediate type and 1.47 gallons to travel 15 miles on a low type road. These figures are based on year around road conditions. As the type of road over which our cars must travel during construction is far below the type on which fleet owners usually operate, our cost of gasoline is much lower than might be expected. These figures in the foregoing table suggest the fact that road improvements pay good dividends.

**Effect of Road Conditions on Various Items of Operating Cost**

| Item of Cost | High Type Road | Intermediate Type Road | Low Type Road |
|---|---|---|---|
| Gasoline | 1.00 | 1.20 | 1.47 |
| Oil | 1.00 | 1.00 | 1.00 |
| Tires and tubes | 1.00 | 2.22 | 2.90 |
| Maintenance | 1.00 | 1.20 | 1.47 |
| Depreciation | 1.00 | 1.10 | 1.24 |
| License | 1.00 | 1.00 | 1.00 |
| Garage | 1.00 | 1.00 | 1.00 |
| Interest | 1.00 | 1.00 | 1.00 |
| Insurance | 1.00 | 1.00 | 1.00 |

Of the different items of expense that enter into automobile operation, no item has shown the reduction in cost of operation as has tire expense. Not so many years ago a tire for a light car cost the owner around $35. This tire, with good luck, might last for 3,000 to 5,000 miles. Today, four tires and a spare can be purchased for the above amount and give the owner 10,000 to 15,000 miles. Better construction of tires and improved roads have entered largely into this reduced expense of car operation. The highway department buys its tires under contract and only as needed, thereby making it unnecessary to carry a stock of tires on hand.

**Fuel Costs.**—Gasoline and oil: In the four years' period covered by the first table, highway department cars used an average of 16.54 miles per gallon at an average cost of 0.1431. A 1-cent increase per gallon would have increased this cost per mile 7-100 of 1 cent per mile.

**Maintenance.**—Repair and Labor Replacement Parts. The department has no shops or mechanics to overhaul and keep in repair its fleet of automobiles. A chief or traveling mechanic is employed to inspect and supervise all overhauling and repair work on department cars, except minor repairs necessary to the operation of department cars which are made in the field. Annual overhauling is given each car in the winter months by authorized dealers in the division point where the car is operated, under supervision of the department chief mechanic. Better constructed cars and improved roads are reducing our cost of maintenance.

**Estimated Average Saving in Automobile Operating Costs Due to Road Improvement Annual Mileage, 11,000 Miles**

(Savings in Cents per Mile)

| Class of Auto | Low Type Changed to Inter. Type | Int'mediate Ch'nged to High Type | Low Type Ch'nged to High Type |
|---|---|---|---|
| Light Four | 1.01 | 0.92 | 1.93 |
| Light Six | 1.24 | 1.13 | 2.37 |
| Medium Six | 1.40 | 1.28 | 2.68 |
| Heavy Six | 1.55 | 1.45 | 3.00 |
| Average car | 1.07 | 0.90 | 2.06 |

**Storage.**—The department does not favor the payment of storage expense on its cars during the construction season, approximately April 1st to November or December. No appreciable depreciation, it is considered, is occasioned by allowing its cars to remain outside at nights during the warm weather. Neither is the operation of the cars affected by outside storage during this period.

The average cost for storage on all department cars is approximately $30 per year per car. Twenty-five per cent of the department cars are operated the entire year on maintenance and snow removal, and are required to be kept in warm storage during the cold season.

**Overhead.**— Depreciation: Depreciation is the result of partly mechanical deterioration and partly of obsolescence. About one-half each. This department uses a system of charging off a certain percentage of the cost price each year, as depreciation on its automobiles. The following table shows how this estimated depreciation compares with the actual depreciation on 38 light four cylinder cars sold during a four year period. Depreciation is taken as the difference between the purchase price and the sale price of the old car, or its trade-in value:

**Depreciation Figures**

| | Cars Cost | Sold For | Depreciat'n | Dep. per Mile |
|---|---|---|---|---|
| Actual Depreciation | $19,520.72 | $5,253.74 | $14,266.98 | $0.0162 |
| | | Est. Value | | |
| Our Est. Depreciation | 19,520.72 | 4,510.91 | 15,520.72 | .0171 |
| Actual Depreciation | 73% | | | |
| Est. Depreciation | 74% | | | |

Difference between actual depreciation and department's estimated depreciation—1 per cent.

License, insurance and interest on investment are other fixed overhead expenses and remain the same whether a car travels 5,000 miles a year or 10,000 miles per year.

# ROADS and STREETS

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## Hoover Construction Program Lives Up to Expectations

The success of the Hoover plan of speeding up construction during dull times is now assured. On the last day of June the president announced that for the first six months of 1930 expenditures for public works had exceeded those of the corresponding period of 1929, by 12 per cent, and that a greater excess will occur during the next half year.

He pointed out that it takes time to initiate any marked expansion in so great an industry as the construction industry, for surveys and plans must first be made. He also pointed out that many of the federal appropriations did not become available until July 1.

With a note of pardonable pride President Hoover stated that this is the first time in history that a concerted and successful effort has been made to increase public works expenditures during a business depression. Hitherto cities, counties and states have followed the lead of many private corporations in curtailing construction during "hard times," for outcries were raised against increasing taxes at such times, and the outcries were heeded by the politicians. This time, however, the governors of all the states were invited to join in a nation wide expansion of public works for the purpose not only of shortening the period of business depression but of providing employment at a time when there would not be jobs enough to go around. Not only were state and municipal heads enlisted in this great economic experiment, but also the heads of railways, public utility companies and large industries. The result has been an expansion of railway and public utility construction analogous to that in public works.

We venture the prediction that this experiment—now well beyond the stage of doubtfulness—will prove to be the most important feature of the Hoover administration. His combined engineering and business experience gave him confidence that construction expansion would serve to restore confidence and thus quickly to renew the usual business activity. Census statistics of unemployment now being made public, show that the percentage of unemployment is much smaller than had been supposed. This also will serve to restore general confidence, for there is no "whistling in the dark" as far as these census data are concerned. The same holds true as to the 12 per cent increase in public works construction.

It will be recalled that in January the forecast was made that public works in 1930 would involve fully a 10 per cent increase over 1929. At the end of the first half of the year, it is seen that that forecast was conservative. So when President Hoover now announces that the last half of the year will show an even greater percentage increase, there should be general rejoicing.

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## Man's Most Important Invention

Perhaps the most important of all inventions is the wheel and axle. The earliest records of wheeled vehicles are Egyptian. It is possible that the Chinese wheel-barrow was invented prior to the Egyptian two-wheel car or chariot.

Since mountain roads in Egypt were often only 4 ft. wide, their cars must have been very narrow. In going through Pompeii one is impressed by the exceeding narrowness of the streets, and especially of the parts that formed the roadway for chariots. In most instances this roadway is wide enough for only one narrow vehicle. At a street intersection there are high stepping stones, one of which is between the grooves worn in the pavement by the wheels, this stone being high enough to avoid stepping in the muck that probably existed in the trackway, but low enough to clear the axles of the chariots and carts.

In Naples, even today, two-wheel carts predominate, which probably indicates that four-wheel vehicles, at least for trucking purposes, are relatively modern.

In China there is only an insignificant mileage of roads wide enough for the use of motor cars. Narrow as were most of the Egyptian and Roman roadways for vehicles, those of China were narrower, probably because horses were not used. Even now the horse is not commonly used in China. China will doubtless pass directly from man-power to gasoline-power in vehicle propulsion, but the change will be rendered exceptionally difficult because of the narrowness of the roadways.

Flanged wheels on iron rails were first used about the year 1800, the invention being that of William Jessop of England. This marked the next great invention associated with the wheel and axle.

Next came an invention of supreme importance, the pneumatic tire. In 1843 an English civil engineer named R. W. Thompson patented this device for use on horse-drawn vehicles. It was never much used until the advent of "the safety bicycle" about 40 years later.

"The ball-bearing, invented by an Englishman named Bonn, is another epoch-making invention," says the Encyclopedia Americana under Bicycle, although it fails to list this important invention under Inventions where a chronology is given of the most important inventions since 1620. Incidentally it may be added that

no biographical sketch of Bonn, Thompson or Jessop is to be found in either the Americana or the Britannica. Hence three of the most important inventors in the history of the wheel have received no biographical recognition by the two most commonly used encyclopedias. When these omissions are contrasted with the thousands of biographical sketches of men who did nothing but talk, one is impressed with the idea that the talkers still rank higher than the doers in the estimation of the encyclopediaists.

Not long ago we had occasion to look for a sketch of the German who invented wood-pulp paper, but could not find it. He may have got his great idea from examining wasps' nests, as the story goes, but since no other human-being in the long history of mankind had wit enough to take an industrial hint from those fiery but ingenious insects, one would expect at least an inch of typed information in the encyclopedias about that man.

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# A New Profession, Research Engineering

The opening of a decade serves as a milestone where we should pause to review the economic progress of the preceding ten years. In America what has been the most outstanding economic development since January, 1920? There will be many differences of opinion. We suggest consideration of the rapid increase in the number of research laboratories as being the most important economic development, if not during the past 10, then during the past 20 years.

As we recall it, less than a decade ago "The Chemical Engineer" took the U. S. Steel Corporation to task for not having a research laboratory. Now it has one. This sort of advance has become a common thing among big American corporations. The next decade will probably witness the wide adoption of research methods by American corporations, small as well as large.

In the January issue of "The American Magazine," there is an interview with C. F. Kettering, president and general manager of General Motors Research Corporation. Note the title of that corporation, and bear in mind that it is a subsidiary of the world's largest manufacturer of motor vehicles. Mr. Kettering is a "famous research engineer," to use the designation that appears in that interview. Note also that designation. Ten years ago the title "research engineer" was almost unheard in America. Now there are probably several thousand who claim it.

"In his (Kettering's) laboratories at Detroit he uses his time and that of some 450 physicists, chemists, electrical engineers, mechanical engineers, mathematicians, and mechanics finding fault with General Motors products and thinking up ways to make them better and different."

About 14 years ago we gave the reason why the American Telephone and Telegraph Co. had been able to perfect transcontinental telephony. (See "Inventing an Inventor" in "Engineering and Contracting," Nov. 29, 1916.) That article ascribed the successful solution of that telephone problem to the then novel practice of cooperative research, in which a new combination of brains was devised to solve the problem. The article was widely quoted because of the novel idea that it described—cooperative research.

Cooperative research even 15 years ago was not entirely new in Germany, for several manufacturers of chemical products had well manned research laboratories. But shortly after the world war ended in 1918, when the du Ponts announced that they had organized a research laboratory that employed 3,000 technical men and assistants, there was open-eyed astonishment the world over. How could 3,000 researchers keep busy in any laboratory? That seemed incredible scarcely more than 10 years ago.

Many an engineer is dissatisfied with his economic prospects. To those that have a taste for research and invention, a comparatively new field is open. How to enter that field we do not intend to discuss now.

Many a young man is contemplating taking an engineering course, but is in doubt as to the college to attend and the course to take. We suggest giving preference to a course and a college that offer good training in research methods. Unfortunately few colleges specifically provide such training, for it has been erroneously thought that inventors and discoverers are "born and not made," whereas the fact is that they are born and made. More often than not they are wholly self-made, but this was equally true of civil engineers less than a century ago. The Military Academy at West Point was the first American college to teach any sort of engineering, and it was founded in 1802, "and for about 30 years was the only organized agency for engineering education in America." In 1865 there were fewer than 300 graduates of American engineering colleges exclusive of West Point; yet this country even then had made great engineering progress, largely under the direction of self-made engineers. So it has been with our research achievements up till very recently; but at last it is beginning to be realized that research engineering can be and should be taught as such.

When many young research engineers shall have been graduated, it will not surprise us if their achievements will revolutionize our present educational methods in every branch. After all, a college education accomplishes little that is worth while if it does not train a man to be a systematic, thorough investigator. So even now, the research spirit that is developed at college is the best part of any scientific training received there. However, that sort of training is usually a by-product, whereas it should be the main product, regardless of the degree of native originality of the student or his intended occupation in after life.

Every one of us has at least a modicum of originality. Every one of us is competent to search for and classify information, and the great majority of us can draw correct inferences if we have secured adequate data. Research training develops such native originality as we possess; but even if it failed to do that, it would still be excellent training, for it would habituate men to get the facts and all the gettable facts. Unfortunately, that sort of training is not yet very prominent in many of our schools and colleges.

H. P. Gillette

# New Equipment and Materials

**Recent Developments in Machines, Tools and Materials in the Road and Street Field**

## New Tractor Crane

Speed in hoisting and handling is the outstanding feature of a new tractor crane announced by The N. P. Nelson Iron Works of Passaic, N. J., as an important addition to their well-known line of material-handling equipment.

Power is supplied by a McCormick No. 20 industrial tractor, the wheel base being lengthened to 98 in. and the width across the traction wheels increased to 89 in. The four usual forward speeds of the tractor are retained with one speed in reverse. The tractor is suspended in the chassis by the rear axle housings and the front axle pivot. The crane is stable for its rated load and reach without chocking the front axle, so that with its three-point support it can work on uneven ground with ease and safety.

A direct drive from the tractor engine makes the crane motions entirely independent of the transmission and clutch controlling the travel, so that hoisting, topping and swinging may be performed simultaneously with travel forward or back without interruption by shifting gears—a great assistance in quickly spotting a load. The entire crane mechanism may be cut off by the master clutch on the direct drive, saving the machinery from unnecessary wear when not in actual use.

Reduction gears, with reversing clutches for topping and swing, are enclosed in two heavy cast iron oil-housings which are carried one on each side outside the frame. By taking out eight accessible bolts either gear box may be removed without disturbing the hoisting or topping drum shafts which remain mounted between the frames. Convenient handholes are provided for inspection of gearing and attention to clutches and lubricant. The gear boxes are bronze bushed throughout and careful attention has been given to the supply of oil to all bearings. Rawhide oil seals on shaft openings prevent the escape of lubricant.

Topping and swing motions are reversed by pairs of oversize friction clutches controlling self-locking cut worm gearing. The swing unit terminates in a sprocket drive to bevel gearing under the mast, while an open crab coupling on the topping unit engages the end of the topping drum shaft. Reduction gears for driving the hoisting drum terminate in a stub shaft carrying a similar crab coupling on the inner face of the box and a capstan-head on the outer face.

The hoist-drum shaft is located directly under the mast and carries a 14-in. free shifting drum with a powerful asbestos-faced cone clutch, ample foot brake and a pawl for holding the load. The thrust screw is formed of a pair of

New Tractor Crane

heavy iron castings with a carefully cut square thread and separate provision for lubrication; adjustment for wear is made by rotating the stationary half. The drum itself is mounted on large Timken roller bearings and a separate Timken thrust collar is placed between the drum and the thrust screw.

The mast is a steel casting which revolves on double ball bearings 21 in. diameter contained in a massive cast steel base. Two lines run to the rooster, one line being the four-part topping rig and the other the hoisting line. For general service a weighted fall block is provided which may be used as a deadweight to overhaul the single hoisting line for loads under about 1,000 lb., and which can be quickly changed to make a two-part fall for handling heavier loads. For warehouse work where only lighter loads are handled a more compact loose hook and weight can be furnished.

The telescoping boom is adjustable between 12 and 17 ft. length, two heavy fids being provided for safety. The spar is fabricated from welded steel plate and carries a gooseneck at the peak. With boom lowered, the height from floor to top of rooster is 9½ ft.

The hoisting drum is geared to give a hoisting speed of 200 ft. a minute on the single line with engine at full throttle speed of 1,000 r.p.m. Loads of 1,000 lb. and under are handled with surprising ease and rapidity, anywhere within the 17½ ft. maximum radius of the crane. Loads up to 2,000 lb. can be handled within 10 ft. radius, and directly in front the crane will pick up loads of 3,000 lb., though these should not be swung at the side.

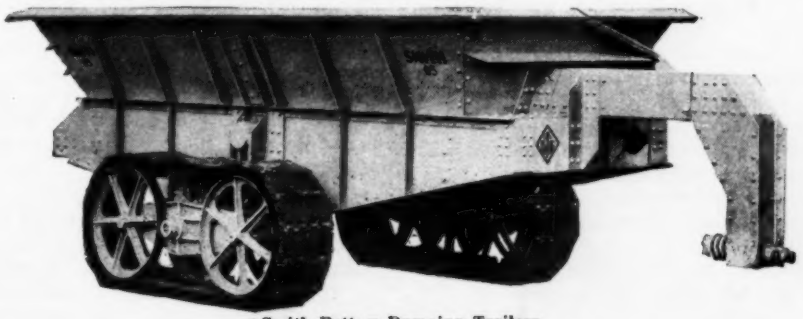
## Adams Now Selling Smith Trailers

J. D. Adams Co., Indianapolis, Ind., has announced their taking over the sale of Smith bottom dumping trailers in states covered by direct factory representatives. These trailers come in both crawler and round wheel types from 5½ to 8½-yd. capacities and for both elevating grader and shovel loading.

Smith crawler trailers are equipped with "Amsco" tracks made by the American Manganese Steel Co. J. D. Adams Co. claims that the few working parts, and high percentage manganese steel used in track links and idler wheels, have reduced track wear and breakage to a minimum. The steel used here is 13 per cent manganese and is claimed to be one of the most practical wear resisting metals known.

The trailer bodies are of all-riveted construction with heavy railroad car bulb angles around top of body and partition in the center to protect the body and arched axle from loading equipment.

The cable wind-up mechanism operates through reduction gears for easy operation. The doors are swung on chain hinges and there are no obstructions to prevent the doors from quickly discharging the load. Smith trailers have the high straight sides similar to long established dump wagon practice. Sufficient material is carried in the straight sided portions to dump, even when the material is very sticky, and this action, it is claimed, breaks any arch which may have formed across the sloping sides.

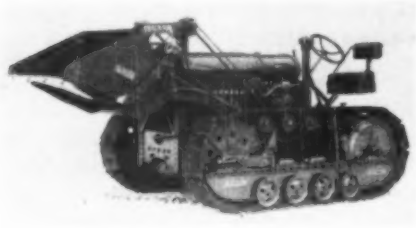


Smith Bottom Dumping Trailers

Both crawler and round wheel types are designed to operate singly or in trains. Literature and detailed information may be obtained by writing to J. D. Adams Co., Indianapolis, Ind.

## New Trackson Shovel

A new Trackson shovel, developed by the Trackson Co., Milwaukee, Wis., was displayed for the first time at the Road Show at Atlantic City.



New Trackson Shovel

This new Trackson shovel is built of special, super-strength steel castings and heavy, re-inforced structural steel. The bucket proper is made of ¼-in. steel plate with a cutting edge of special plow steel ½ by 6 in., and it is claimed it will stand up under the hardest usage, such as digging into hardpan, rocky soil and very abrasive materials. The bucket is controlled by a mechanical clutch-operated hoist, a method which has thoroughly proved its efficiency and which is used by many manufacturers of big power and steam shovels and other hoisting equipment.

The main side frames, made of heavy structural steel, are given additional strength by a special saddle casting which connects the two members and assures positive rigidity. The main frame is supported only at the front and the rear of the tractor and absorbs all thrusts and strains, so that the tractor is stated to merely serve as the power plant and is relieved of all the shocks to which excavating equipment is subject.

A single level controls the bucket and an automatic clutch release eliminates any possibility of raising the shovel too high. A special feature is the bucket return, which is either power-operated or automatic, resulting in a considerable saving of time and ability to handle more material with less effort.

The new shovel is stated to have a digging range from 8 in. below ground level to 40 in. above. The sharp cutting edge of the bucket enables it to dig into very hard surfaces, and as it is raised the bucket tilts back, preventing spillage of the material which is being carried.

A very important advantage of the Trackson shovel is its portability. It may be mounted either on wheel tractors or on crawler units like the Trackson McCormick-Deering shown in the illustration.

Mounted on the tractor this shovel has the low overhead clearance of only 69 in.

## New Rawls Motor Scythe

A new motor scythe with which it is claimed one man can easily do the work of 15 or 20 men using the ordinary old fashioned scythe, has been placed on the market by the Rawls Manufacturing Co., Streator, Ill. The new scythe weighs only 114 lb. and is therefore handled easily anywhere. It is powered by a ½ hp. 2-cycle Johnson gasoline motor. It has a 3-ft. cutter bar and therefore cuts a good wide swath. The details of this machine include:

One piece steel frame (no bolts or rivets)

3 ft. cutter bar

32 in. ball-bearing wheel

Gasoline engine propelled sickles

½ hp. 2-cycle Johnson motor

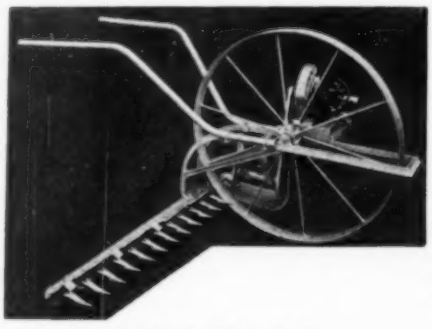
Fuel consumption, 6 qt. per 8 hours

Capacity gas tank, 3 qt.

Net weight, 114 lb.

Weight crated for domestic shipment, 150 lb.

Weight crated for export shipment 200 lb. Cubic feet, 15



New Rawls Motor Scythe

Full catalog information will be sent on request by the Rawls Manufacturing Co., Streator, Ill., who have been manufacturing mowing machines exclusively for 16 years.

## Ash Collection Equipment

The Department of Public Works of the City of Philadelphia, Kan., recently installed a fleet of motor trucks equipped with dustless ash collection bodies.

The trucks are a part of a group of 34 heavy duty 6-cylinder Sterlings recently purchased by the city, of 7 to 8-ton capacity. The bodies were supplied by B. Nichol & Co. of New York City. Due to their construction, they are not only dustless, but also claimed to be labor savers, as the ash collectors have no reaching or shoveling to do when unloading their baskets into the truck.

A steel trough lowers down close to the ground, making it convenient for the collector to deposit the contents of his basket without strain or exertion. The trough operates on a davit-like mechanism with gears that lower or

Ash Collecting Equipment of Philadelphia, Pa.

raise it over the sides of the truck. When filled, it is mechanically raised and its contents are dumped into the tank receptacle. A steel covering prevents dust from escaping. When the tank is filled, the trough remains in this position "hermetically sealing" it until the load is ready to be deposited at the dumping grounds.

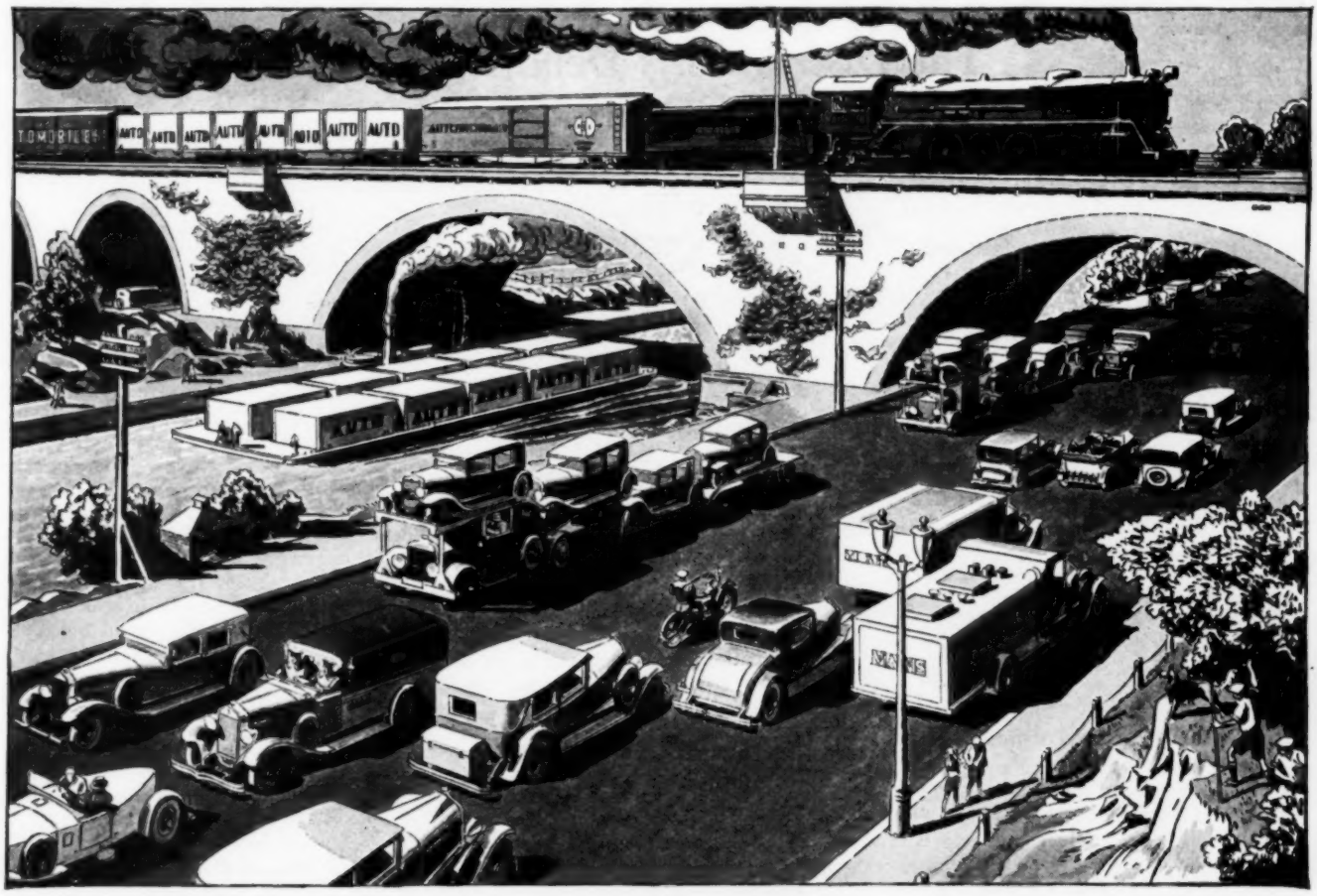
They unload on the same principle as a dump truck. A door in the rear is opened and with the use of a Heil hoist, the front end is elevated, the contents soon disposed of, and the truck ready for another load.

## Faience Street Signs

An unusual and attractive system of street signs has been installed at Cranford, N. J. In this system the posts are reinforced concrete, carrying on the four sides the street names in glazed tile panels. The color effect of the glazed tile is very pleasing and legible and the general effect is attractive without being conspicuous in either business sections or in rural settings. The contrast in colors and the large block letters can be read clearly for long distances. The tile panels used in these signs are manufactured by the Mueller Mosaic Co., Trenton, N. J.

Street Sign with Glazed Tile Panel

# ..and 15,000 new cars *every day*




It's easy to talk of over-production of automobiles. But why not turn the whole proposition inside out—and speak of under-production of roads?

Under-production—not only because we spend too little on roads but also because we so often spend it on roads that cost too much.

"Good roads at low cost" is the only answer to the mounting birth rate of automobiles. *At low cost* means more miles of good roads from every million of the nation's two-billion-dollar annual road bill.

No road-building, road-maintaining material has better right to associate itself with the words "Good roads at low cost" than Tarvia. For 26 years, Tarvia has been helping thrifty communities put the low-cost principle into practice.

This priceless experience is at the service of any highway official who cares to use it. 'Phone, wire or write our nearest office.

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GOOD ROADS
at LOW COST

# DISTRIBUTOR NEWS

## *The Distributor's Department in the Gillette Construction Group*

### National and International Distribution Announced for Madsen Iron Works

Until now the Madsen Iron Works, makers of portable asphalt plants, has confined its operations to west of the Mississippi, but announce negotiations are now in progress for establishing adequate representation in the principal European centers, and sufficient interest in their eastern plants to justify plans for national distribution.

The Madsen Iron Works, Huntington Park, Calif.

Twenty years ago Martin and Peter Madsen established their first iron foundry on a leased city lot with fifty feet of frontage. Today the Madsen Iron Works occupies its own site of five acres in Huntington Park (a suburb of Los Angeles), California, and the original staff of six people has grown to 200. It is said that the building of the first Madsen plant was the work of almost a year, whereas today a complete 1,000-lb. plant can be turned out in from three weeks to thirty days.

During the first ten years this organization engaged in making units for "stick" plants, but in 1920 they built their first complete, all metal, wholly portable plant bearing their name. This first plant was of 1,000-lb. capacity, according to Western plant rating, and was purchased by the

K. A. Richardson, Sales Manager

Mr. Martin Madsen, President, Madsen Iron Works

Southwest Paving Company of Los Angeles. Today this manufacturer is making portable tower plants in capacities up to 6,000 lb. per batch. Distribution of these plants is now reported not only in North and South America but in far away Russia.

The Madsens are said to have patented and retained control over many

A. H. Ziegler, Chief Engineer

features of their paving plants. Mr. Martin Madsen, president of the company, is chief of the paving plant division. K. A. Richardson, a graduate engineer, is sales manager, and A. H. Ziegler, chief engineer.

Distributing companies include: Edward R. Bacon Company, San Francisco; Western Road Machinery Company, Portland, Ore.; Olympic Machinery Company, Seattle; Stannard Machinery Company, Salt Lake City, Utah; H. W. Moore Equipment Co., Denver, Colo.; Wm. H. Ziegler Co., Inc., Minneapolis, Minn.; George W. Smith Company, Dallas, Texas; W. R. Grace & Company, operating throughout South America, are at present their most important foreign distributors.

**Announcement**

Blaw-Knox International Corporation is the new name for the Export Organization of the Blaw-Knox Company, which was formerly known as Milliken Brothers-Blaw-Knox Corporation, which in turn succeeded the original Milliken Brothers Manufacturing Company.

This change in name is due to the larger scope of the company's activities and thoroughly identifies the Export Company as such. The change of name embraces no change in personnel and the offices will remain as formerly, in the Canadian-Pacific Building, New York City.

Blaw-Knox International Corporation handles all the products of the Blaw-Knox Company including road building equipment, clamshell buckets, central mixing plants, steel bins, measuring batchers, truck turntables, dragline buckets, agitator truck bodies, steel buildings, etc., in South America, the West Indies and other parts of the world where the Blaw-Knox Company is not otherwise represented.

**G. C. Theall Represents Buhl in New York**

Mr. George C. Theall has joined the Buhl Company, manufacturers of portable air compressors, as manager for the Eastern district. Mr. Theall comes to the company with several years experience in the compressor field. His broad knowledge of this field will prove very helpful to the Buhl dealers in the Eastern territory.

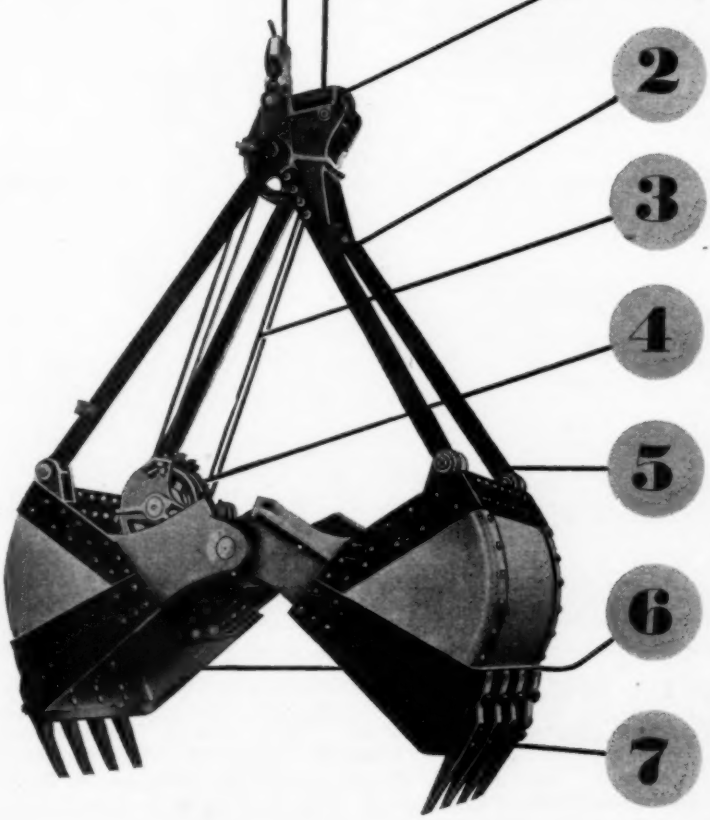
Mr. Theall will be located in New York City, the center of the activity for the district.

**C. H. Redman Joins FWD Staff**

Mr. Charles H. Redman, formerly with the Ferro Machinery and Foundry Company, Cleveland, Ohio, has joined the Four Wheel Drive Auto Company's engineering staff to devote his time to the study of adaptation of their trucks to special and unique services. Mr. Redman is a graduate of the Michigan School of Mining Engineering at Houghton.

**Service Exchange** has been helpful in securing desirable representation for the products of many manufacturers and in assisting distributors in building up their lines. Do not hesitate to make use of this service which the publishers present as a regular feature of this magazine. For information write, Editor, Distributor News.

# In BLAW-KNOX CLAMSHELL BUCKETS



**1** **ONE PIECE HEAD BLOCK**

Provides complete protection for closing line and avoids excessive cable wear caused by wobbly head construction.

**2** **FORGED STEEL CORNER BARS**

*Not* hot rolled upset stock, but forged from billet. Will stand abuse.

**3** **SIMPLE CABLE REEVING**

No "S" bends or small guide sheaves--multiplies the life of cable in service.

**4** **BALL BEARING LEVER ARM SHEAVES**

One of the most valuable and economical features in clamshell design. Reduces friction--sand and grit are sealed out--lubrication sealed in.

**5** **EFFECTIVE LUBRICATION**

All moving parts not provided with Ball Bearings are equipped with Alemite Grease Gun connections.

**6** **HEAVY SCOOP LIPS**

Extend entirely around scoop from hinge to hinge. Specially hardened cutting edges which retain their sharpness.

**7** **ALLOY STEEL TEETH**

Made to resist abrasion and wear to the utmost. Attached with special alloy steel bolts insuring rigidity and strength.

These and other differences in Blaw-Knox construction making for longer life and effective usefulness in service are fully described and illustrated in Catalog 1059. Ask for it on the coupon or your business letterhead.

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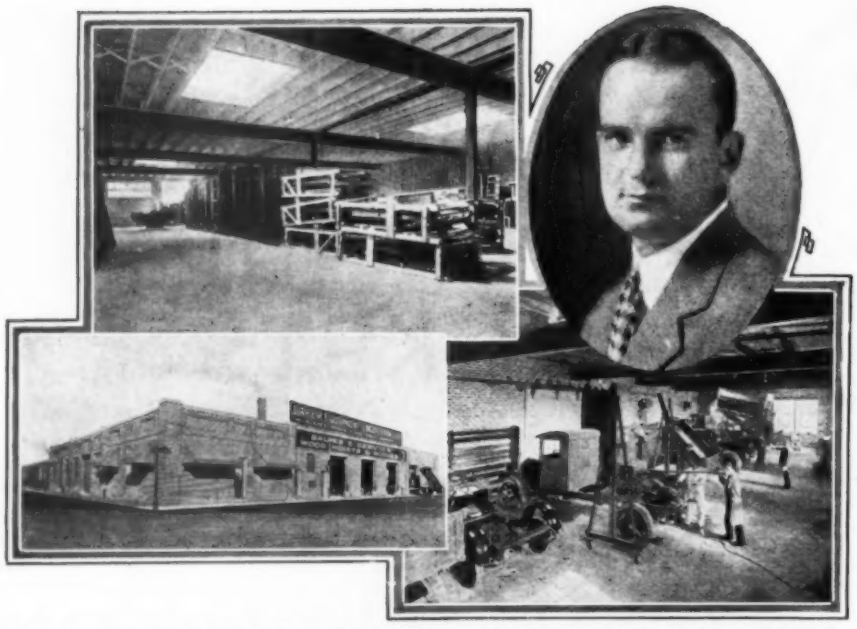

Exterior view of Richmond plant of Baker Engineering Equipment Co., interior of storage section, and partial view of installation department, with picture of Mr. Joseph B. Baker, president, in inset

## Baker Equipment Company Anticipates Big Year

Mr. Joseph B. Baker, president of the Baker Equipment Engineering Company of Richmond, Va., and Charleston, W. Va., one of the largest distributing companies in the southeastern territory, states that 1929 held the record for business in the ten years since the organization of his company, and that the first five months of 1930 indicate that the 1929 record will be shattered this year.

Starting ten years ago in an unpretentious shed on the outskirts of Richmond, Va., as representatives of one or two manufacturers of truck equipment, this company today occupies for its truck equipment business 24,000 square feet of space. The Charleston branch is a complete plant in itself and was established last year to better serve the truck dealers in the West Virginia territory.

Hydraulic and mechanical hoists, dump bodies of all types, truck bodies, winches of various kinds, transmissions, etc., are among the wide line of truck equipment which this company handles for leading manufacturers.

"To serve quickly, efficiently and economically by applying modern and tried engineering methods to each individual equipment problem is the method to use in serving the truck dealers and the truck users," stated Mr. Baker in speaking of the unusual growth of their organization. The company carries complete stocks of equipment, maintains a modern machine shop and a personnel prepared to give immediate service.

Charleston plant of the Baker Company, with picture of Mr. I. Bedford King, manager, in inset

## G. F. Lowe Co. to Represent The Foote Company

The Foote Company, Inc., Nunda, N. Y., manufacturers of MultiFoote pavers, announce that they have appointed the G. F. Lowe Company, of Chicago, Illinois, as their general distributors in the north central territory, extending from western Michigan to Nebraska and from Kentucky to the Canadian border.

The Lowe Company will carry in stock new paving mixers and a complete line of repair parts, as well as to offer complete service for all paving mixers in the territory above mentioned. This company has an office at 612 North Michigan Avenue. They are also operating a warehouse exclusively for paving mixer repair parts and service at 2811 West Fulton St., Chicago.

Mr. Lowe, president of the G. F. Lowe Co. and his entire organization, bring to this new connection a ripe experience.

## New Sales Policy for Allis-Chalmers Tractors

Model U industrial tractors designed by Allis-Chalmers with the specific thought of attaching equipment to it for a complete industrial unit, will hereafter be sold through the Monarch Tractors Division at Springfield, Ill., according to announcement made at a recent three-day demonstration of this equipment in Milwaukee. Sales control will be in charge of R. W. Gotshall and W. Ellzey Brown.

Addition of the Model U to the Monarch line will give the Monarch organization both wheel and crawler type tractors, and dealers handling equipment for use with these tractors will have both types of tractors available. Manufacturers represented in the group whose equipment is built for use with the Allis-Chalmers tractor, include, Wehr, Galion, Shaw-Enochs, Schramm, Blair, Trackson, Waterman, Sauerman, Hughes-Keenan, W. K. M., Bay City Shovels and several others and all participated in the demonstration at Milwaukee.

The meeting closed with a banquet at which H. C. Merritt, R. W. Gotshall and Arthur Hughes were the principal speakers. E. R. Brooks and E. H. Graves had charge of field demonstrations. Those in attendance from the Monarch organization of district managers included: J. C. Allison, Detroit; E. W. Arnold, Denver; G. R. Conner, New York City; C. J. Deutch, Springfield; V. R. Foley, Greensboro, N. C.; J. P. Gertsen, Minneapolis; E. G. Lohman, Seattle; R. S. Lowe, Dallas; Sam O'Neil, Atlanta; Joe Reeder, Vicksburg; Harry W. Scharber, Oakland; E. H. Starr, Kansas City; H. J. Yoakum, Des Moines; C. F. Reuter and W. H. M. Moore, Canadian managers.

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## FWD Celebrates 20th Year

Guided by the same president, the same secretary and the same treasurer and with the same personnel making up the Board of Directors as those who met when the Four Wheel Drive Auto Company was organized twenty years ago, this company on July 21st celebrated its twentieth birthday. W. A. Olen has served during this period as president and general manager, Frank Gause as secretary and D. J. Rohrer as treasurer.

From an original capitalization of $110,000, which was increased the second year to $250,000, the management reports a capitalization at this time of $1,727,600, all of which has been added from earnings. Harmony among stockholders and directors is evidence of satisfactory handling of affairs, for it is stated that there has never been a minority bloc nor minority report among the entire group.

In 1910 in Clintonville, Wis., a master blacksmith and his two helpers made a beginning in the property of Otto Zachow, the inventor of the basic feature of the FWD truck, and today 750 names are listed on the pay-roll. 280,000 square feet of floor space is represented in the properties of the company, which represent a value of about $1,385,000. In addition to the headquarters at Clintonville and the branches located in all the principal cities of the United States, export service departments are found in South America, England and western Europe, in Russia and the eastern shores of the Mediterranean.

First applying their four-wheel driving principle to the manufacture of passenger cars, the company abandoned this field to devote its facilities to the market for trucks, and presented model "B" of 2-ton capacity, the first of this type of truck to appear in the American market. Today they manufacture a line of ten models, ranging in capacity from one and one-half tons to six and seven tons, a six-wheeler and a fire department truck.

It is said that 15,000 FWD trucks went to the front in the World War, but the speeding up of production for wartime needs was quickly adjusted to peacetime activity because of a briskly stimulated market. It is estimated that during the twenty years of business this organization has distributed in the world's markets goods in excess of $130,000,000.

**A MEETING OF THE CLANS**

**Maybe "Koehrings" aren't Scotch and this heading should read "A Meeting of the Gangs," but the point is they did meet. Two Milwaukee contractors, with two separate sewer jobs, happened to converge with the result that two pull shovels and five cranes all of the same family origin exchange friendly greetings and view the work of the paver being used for pouring concrete for the sewer forms.**

### Announcement

Mr. Stuart R. Ives, vice president and general manager of the Lyle Culvert & Pipe Company, Minneapolis, has been appointed general manager of the Armco Culvert Manufacturers Association, with headquarters at Middletown, Ohio.

Mr. Lyle comes to his new position with a background of many years of intimate contact with the culvert industry and with the problems of the road builder, the public official and the engineer in charge of drainage work.

In announcing the appointment of Mr. Ives, the Armco Culvert Manufacturers Association states that the aims and policies of the association will continue to be: "Thorough-going research in all matters pertaining to drainage, engineering assistance in the solution of specific drainage problems and educational publicity to bring the results of the association's work to the attention of those who can profit from it."

### Army Officer Joins Budd

The Edward G. Budd Manufacturing Company, of Philadelphia and Detroit, makers of all-steel bodies and body parts, announces the appointment to its Detroit sales force of Colonel George A. Mix. At the close of the war Colonel Mix resigned from the regular army and has since been connected with the Auburn Automobile Company and the Chrysler Motor Company.

**T. A. Burns Joins Harnischfeger Co.**

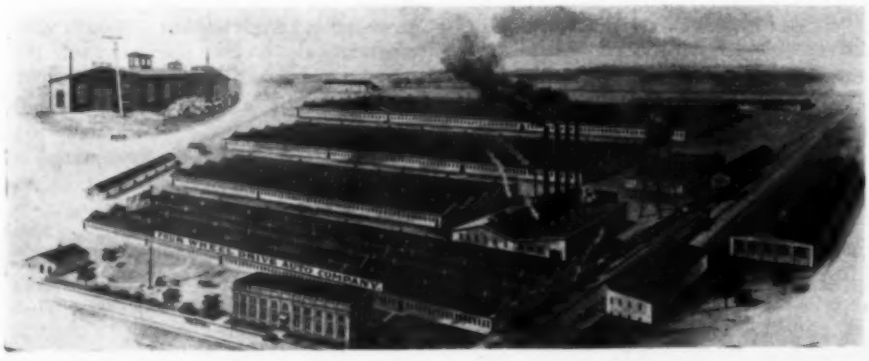
Mr. T. A. Burns, who has had wide experience in selling the larger sizes of excavators, has joined the sales organization of Harnischfeger Corporation. He will work directly out of the general sales department in the home office at Milwaukee.

**The Buhl Company,** manufacturers of the Buhl portable air compressor, is pleased to announce the appointment of the H. O. Penn Machinery Company, 140th Street and East River, New York, as distributors in the New York district.

The H. O. Penn Machinery Company carries a complete line of these compressors and parts in stock. They will give the usual Penn service.

**G. H. Williams Company** announces the appointment of Kratz & McClelland of San Francisco as agents for the northern California territory. Complete stocks will be carried by the distributing company. The Williams Company is located at Erie, Pa., where the "Champion" buckets and "Arch-Girder" trailers are manufactured.

**Hercules Motors Corporation** of Canton, Ohio, reports a nice business on engines in Japan, where K. Hattori & Company, Limited, of Tokio serves as exclusive representative on Hercules products.



**1930 plant at Clintonville, Wis., headquarters of FWD Auto Co., showing increase since 1910**

# ROADS AND STREETS

*Design, Construction, Maintenance and Traffic Control*

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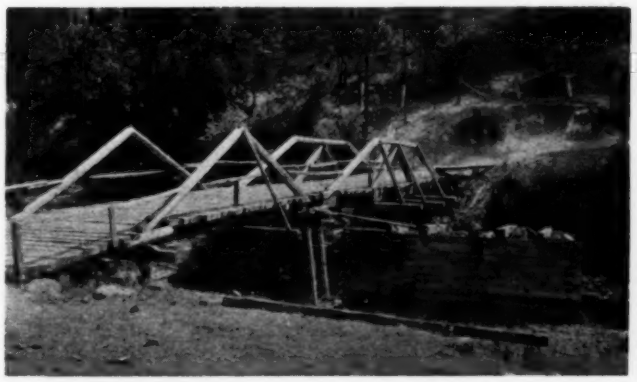

*Timber Bridge of a Former Generation — Totally Inadequate for Traffic*

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*Vol. LXX, No. 9*

## *September, 1930*

**Mixing Cycle and Production in Concrete Paving Work** ..... 305
ANDREW P. ANDERSON

**Two Famous Highway Bridges** ..... 310

**Denver Salvages Asphalt Topping** ..... 311
JOS. C. COYLE

**Road Relocation in New Hampshire** ..... 313
F. A. GARDNER

**Construction of Oil-Mix Roads in New Mexico** ..... 314
R. W. BENNETT

**A Discussion of Road Capacity** ..... 319
N. W. DOUGHERTY

**Nebraska Builds Mixed-in-Place** ..... 322

**Planning County Roads** ..... 325
NORMAN M. BLANEY

**Bituminous Surfaces for Light-Traffic Highways** ..... 329
C. N. CONNER

**Solving the Market Road Problem** ..... 331
JOE L. LONG

**Editorials** ..... 323
**Before and After** ..... 334
**The Road Builders' News** ..... 336
**Recent Books** ..... 338
**New Equipment and Materials** ..... 339
**Snow Removal** ..... 71
**Distributor News** ..... 87
**Useful Equipment Information** ..... 94

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# ADVERTISERS IN THIS ISSUE

## SNOW REMOVAL SECTION — Pages 71 to 86


A

*Adams Co., J. D. 19
*Aeroil Burner Co. 110
*Alan Wood Steel Co. 102
American Bitumuls Co. 93
*American Hoist & Derrick Co. 98
*American Pressed Steel Co. 109
*American Steel & Wire Co. 48
American Tractor Equipment Co. 41
Anthony Co., Inc. 109
Armco Culver Mfrs.' Assn. Insert-63-64
Athey Truss Wheel Co. 110
Atlas Imperial Diesel Eng. Co. 38
Austin-Western Rd. Machy. Co. Insert-27-28

B

*Baker Mfg. Co. 83
*Barrett Co., The 89
*Bates Mfg. Co. 75
Bay City Shovels, Inc. 47
Blackhawk Mfg. Co. 24
*Blaw-Knox Co. 91
Bosch Magneto Co., Inc., Robert 7
*Bucyrus-Erie Co. 49
Budd Wheel Co. 15
*Buffalo Springfield Roller Co., The 106
*Burch Corp., The 107
*Butler Bin Co. 30

C

*Calcium Chloride Publicity Committee 60
Caterpillar Tractor Co. 31
Central Iron & Steel Co. 109
Chevrolet Motor Co. 14
Chicago Pneumatic Tool Co. 52
Cleveland Trac. Co., The 33
*Connery & Co. 111
*Continental Motors Corp. 22
Cyclone Fence Co. 100

D

Davenport Locomotive & Mfg. Co. 83
Dodge Brothers 16-17
*Domestic Eng. & Pump Co. 102
*Dow Chemical Co. 60
Du Pont De Nemours & Co., Inc., E. I. 8-9

E

*Erie Steel Const. Co. 10
*Etnyre & Co., Inc., E. D. 109
Everhot Mfg. Co. 111

F

*Flintkote Roads, Inc. 95
Foote Co. 6
*Foote Bros. Gear & Machine Co. 75
*Four Wheel Drive Auto Co., The 77
*French & Hecht 37

G

*Galion Iron Works & Mfg. Co. 5
Gardner-Denver Co. 54
*Garst Mfg. Co. 110
General Excavator Co. 25
Gillette Publishing Co. 65-85-96
*Gohi Culvert Manufacturers, The 29
*Good Roads Machy. Co., The 79
*Grasselli Chemical Co., The 13

H

Haiss. Geo., Mfg. Co., Inc. 26
Hayward Co. 100
Hazard Wire Rope Co. 50
*Heltzel Steel Form & Iron Co. 105
Hercules Co., The 65
*Hercules Motors Corp. 42
Highland Body Mfg. Co., The 108
*Honhorst, Jos., Co. 110
*Huber Mfg. Co., The 110
Hug Co., The 108
*Hyatt Roller Bearing Co. Second Cover

I

Illinois Wire Mfg. Co. 86
*International Harvester Co., Inc. 35
Iowa Mfg. Co. 32

J

*Jaeger Machine Co., The 111
Johns-Manville Corp. 61

K

*Keystone Driller Co. 51
Klauer Mfg. Co. 81

L

La Plant-Choate Mfg. Co. 85
*Littleford Bros. 12

M

Mack Trucks, Inc. Front Cover
Marion Steam Shovel Co. 53
*Mohawk Asphalt Co. 101
Moritz-Bennett Corp. 106
Mueller Mosaic Co. 108

N

Natl. Equipment Corp. 20-21
Natl. Paving Brick Mfrs.' Assn. 56
New England Rd. Machy. Co. 103
Northfield Iron Co. 86

O

*Ohio Power Shovel Co. 23
*O. K. Clutch & Machy. Co. 111
Olsen Testing Machine Co., Tinius 4

P

*Page Steel & Wire Co. 44
Pioneer Gravel Equip. Mfg. Co. 34
*Pittsburgh Plate Glass Co. 60
Portland Cement Assn. 58

R

*Rawls Machy. Co. 98
*Riddell Co., W. A. 107
Robertson Steel & Iron Co., W. F. 107
*Root Spring Scraper Co. 72

S

*Sauerman Bros. 110
*Schramm, Inc. 107
Shaw Excavator & Tools Co. 108
*Smith Engr. Works 36
*Solvay Sales Corp. 60
Speeder Machy. Co. 55
St. Paul Hydraulic Hoist Co., The Third Cover
*Standard Oil Co. (Ind.) 99
*Standard Oil Co. (N. Y.) 106
*Stockland Rd. Machy. Co. 75
Stolle Road Equipment Co. 111
*Sullivan Machy. Co. 106
*Sweets Steel Co. 110

T

Thew Shovel Co. 57
Timken Roller Bearing Co. Back Cover
*Toledo Pressed Steel Co. 104
Traction Co. 39
Twin Disc Clutch Co. 40

U

United States Pipe & Fdry. Co. 11
Universal Crane Co. 59
Universal Road Machy. Co. 104
Universal Power Shovel Co. 101

W

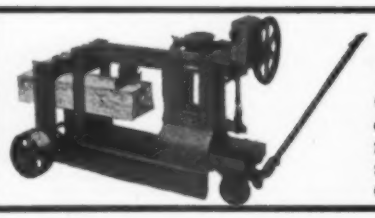
*Warren Bros. Co. 97
Warren-Knight Co. 111
West Process Pavement Co., Inc. 62
Western Crucible Steel Cast. Co. 104
Waukesha Motor Co. Insert-45-46
*Western-Wheeled Scraper Co. 43
*Wheeling Mold & Fdry. Co. 104
Williamsport Wire Rope Co. 66
Wood Hydraulic Hoist & Body Co. 18

Y

Young Radiator Co. 103


***See the Road and Street Catalog & Data Book**

In addition to the advertising messages to be found in this issue of Roads and Streets on the pages as indicated above, condensed catalogs of those marked * as well as other specifications and construction data will be found in the Road and Street Catalog and Data Book, the 384 page annual reference guide for the highway industries, published by the Gillette Publishing Co.

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